CRASH COURSE IN OPERATIVE DENTISTRY

DENTISCOPE

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Caries development & basics

Caries are multifactorial, site specific, dynamic and reversible.

Caries is a dynamic reversible process because the tooth is subjected to cycles of demineralization and remineralization several times per day.

Most commonly acceptable caries theory is: Miller's acidogenic theory

What factors influence caries?

1. **cariogenic oral flora in dental plaque**
2. **cariogenic substrate**
3. **susceptible tooth / host**
4. **host environment**
5. **time**

Q; why does it take months to years to develop a carious lesion?

A: because the carious process consists of alternating periods of dem and rem. + saliva and fluoride can delay the process.

what microorganisms cause caries?

- S.mutans + lactobacilli → in pit and fissure caries
- Actinomyces (naeslundii and viscosus) → root caries

Streptococcus mutans

- Acidogenic = produce acid
- Aciduric = survive in acidic medium
- Metabolize carbs to produce acids (lactic, propionic, formic, acetic)
- Produce **extracellular polysaccharides** – allow bacteria to adhere to each other + make plaque thicker
- Produce **intracellular polysaccharides** – which are converted to acids when free sugar is not available

> **Q: what is the most cariogenic food?** Low molecular weight carbohydrates [Simple sugars] like sucrose, fructose and glucose.
> Simple sugars readily diffuse into plaque, they are readily metabolized by cariogenic bacteria + bacteria use it to make Extra and intracellular polysaccharides

> **Q: why do sport drinks and juices are considered a risk factor for caries?**
> Because they shift the flora in the plaque to a more acid tolerant one + strong acids dissolve the pellicle and predispose the tooth to caries

Pathological factors (demineralization factors)	Protective factors (remineralization factors)
Lack of fluoride	Adequate fluoride
High amount of fermentable carbohydrates	Low amount of fermentable carbs
Low intake of diary food	High intake of diary products
Mature plaque (high numbers of s.mutans)	Low number of s.mutans
Poor salivary protection	Good salivary protection

Which populations are at higher risk for caries?

1- Preschool children: because of night bottle feeding
2- Adolescents and young adults : because of frequent snacking and soft drinks
3- 65 YO and older : because of their medications that might contain sugar or cause xerostomia
4- People in rural areas
5- Refugees
6- People with disabilities

Saliva and caries

Functions of saliva:

1- Forms a protective mucoid layer on mucous membranes protecting it from irritants and dessication.
2- Salivary flow rate – physically removes food and cellular debris + retards plaque formation
3- Carbonic acid / Bicarbonate system and phosphate in saliva buffer low PH
4- Calcium and phosphate in saliva remineralize lesions + keep the integrity of teeth
5- Glycoproteins in saliva form the acquired pellicle to protect the teeth from erosion and abrasion
6- sIgA + lactoferrin + lysosomes + lactoperoxidase provide antibacterial and antiviral properties

Normal un stimulated salivary flow rate	**0.3-0.5 ml per minute**
Normal stimulated salivary flow rate	**1-2 ml per minute**

- Parotid secretions = watery and clear (produce 50% of stimulated saliva and 20% of resting saliva)
- Minor salivary glands = more viscous
- Most of the resting saliva is produced by submand gland → resting saliva is more viscous.

Causes of reduced salivary flow:

1- Radiation therapy
2- Medications
   A. Antihistamines
   B. Antidepressants/ antiphyscotics
   C. Diuretics
   D. Sedatives
   E. Methyldopa
3- Acute and chronic inflammation of salivary glands (sialadenitis)
4- Benign / malignant salivary gland tumors
5- Sjogren's syndrome

age alone doesn't affect salivary flow rate but older people are more likely to take medications that cause reduced salivary flow rate.

Consequences of reduced salivary flow rate:

1- mucositis
2- altered taste
3- difficulty chewing speaking and swallowing
4- teeth sensitivity
5- difficulty wearing dentures

6- gingivitis due to increased plaque accumulation
7- change in plaque flora in favor of candida

** mucosistis = burning and pain sensation in the mouth exacerbated by foods, fruits, carbonated beverages hot drinks and smoking.

Clinical management of dry mouth

Take drug history + salivary flow rate assessment (flow rate peaks in the afternoon – pt should not eat or drink for 1 hour before the test – they can have water)

To alleviate dry mouth:

1- sipping water constantly
2- reduce intake of caffeine containing drinks and smoking
3- avoid astringent products (alcohol containing mouthwashes , strongly flavoured toothpastes)
4- coat lips with Vaseline
5- humidify sleeping area
6- chewing sugar free gums (xylitol gums)
   ** some fruit drops contain artificial sweetners will not cause caries but are very acidic and can dissolve enamel and dentine
7- use salivary stimulants
8- Use sodium fluoride 0.05% NaF
9- 1% CHX gel (Corsodyl) should be applied by the patient in a custom made tray for 5 mins daily for 14 days

Salivary stimulants :

1. SST (Sinclair) = a saliva stimulating tablet (contains phosphate buffer so it doesn't damage the teeth)
2. Salivix (provalis) lozenges / saliva orthana
3. Sprays (glandosane , saliveeze)
4. Pilocarpine hydrochloride stimulates parasympathetic nervous system → increase salivary flow rate
   - **Side effects:** sweating, flushing, nausea , diarrhea, slow pulse rate, fall in BP , reflex narrowing of airways
   - Contraindicated in pts with cardiac and respiratory problems

Pts with dry mouth recall interval:

- Caries recall every 3 months
- Stimulated flow rate measured every 3-4 month
- CHX gel application every 3-4 months

** CHX is inactivated by sodium lauryl sulfate in toothpaste – advise pts to rinse the toothpaste thoroughly before they apply the gel

Diet and caries

- **Intrinsic sugars =** sugars that are integrated in the structure of food
- **Extrinsic sugars =** free form sugars or sugars added to food like biscuits and cakes – more cariogenic because they are readily metabolized by the bacteria

> if fruits are juiced then the sugar becomes extrinsic
> Milk , cheese, yougurt are not cariogenic
> **NMES**= non milk extrinsic sugars→ most damaging – recommended daily dose of NMES = 60 d/day or 10% of daily energy intake
> Raw starch (vegetables 0 → not cariogenic but refined starch (chips) → highly cariogenic
> Dried fruits → sticky and contain some extrinsic sugars (that form due to the drying process) → cariogenic

- People who work many night shifts have higher caries rate
- Drug abusers have sugar cravings

Caries classification

1- According to type of affected tooth structure
Enamel caries/ dentine caries

2- According to their anatomical site
Pits and fissures/ smooth surface/ root

3- According to their activity – status of the lesion
Active: demineralization is exceeding remineralization – lesion progresses over time
Arrested: demineralization has stopped and remineralization repaired the lost mineralize but not the lost collagen – lesion does not progress over time
Remineralized : arrested lesion that has increased mineral content, hardness and surface shine

4- According to rate / speed
Acute/chronic

5- According to their extent / severity
Incipient / mild / moderate/cavitated/ advanced /rampant (radiation caries, nursing bottle caries)

6- According to their origin:
Primary caries: caries that occur on a surface that doesn't have previous carious lesions or restorations.
Secondary caries: caries that occur on a surface that had a previous lesion (around/ under a restoration) – indicates microleakage
Residual caries: caries that are left in a prepared cavity by intention or by accident.
Acceptable: leaving affected dentine near the pulp
Unacceptable : on prepared enamel walls or near the DEJ (because that is where the
forward caries: spread caries cone in the enamel is same or larger than cone in dentine
backward caries: spread of caries along the DEJ exceeds caries spread in enamel

GV black classification

Class 1	Pits and fissures of posterior teeth, buccal and lingual pits on molars, palatal grooves on maxillary incisors
Class 2	Proximal surface of posterior teeth
Class 3	Proximal surface of anterior teeth
Class 4	Proximal + incisal corner of anterior teeth
Class 5	Cervical areas- buccal and lingual of all teeth
Class 6	Incisal and cusp tips

Mount and Hume classification - site and size

Site	Size
	0=No cavity → was added later in 2000 [no restoration is needed – tx by remineralization + fissure sealants]
1= pits and fissures	1=minimal involvement of dentine just beyond remineralization alone
2=contact areas	2= moderate involvement of dentine [cavitations in dentin without weakening of cusps]
3= cervical areas	3= enlarged and remaining tooth structure is weakened
	4=extensive caries and bulk loss of tooth structure has occurred.

EX: 2.4 = extensive caries and bulk loss of tooth structure occurring on the contact area

Drawbacks of site/size classification: It indicates only lesions that need intervention, does not indicate lesion depth or activity.

ICDAS code	0	1	2	3	4	5	6
							
Definitions	Sound tooth surface; no caries change after air drying (5 sec); or hypoplasia, wear, erosion, and other noncaries phenomena	First visual change in enamel; seen only after air drying, or colored change "thin" limited to the confines of the pit and fissure area	Distinct visual change in enamel; seen when wet, white or colored, "wider" than the fissure/fossa	Localized enamel breakdown with no visible dentin or underlying shadow; discontinuity of surface enamel, widening of fissure	Underlying dark shadow from dentin, with or without localized enamel breakdown	Distinct cavity with visible dentin; frank cavitation involving less than half of a tooth surface	Extensive distinct cavity with dentin; cavity is deep and wide involving more than half of the tooth
Histologic depth		Lesion depth in P/F was 90% in the outer enamel with only 10% into dentin	Lesion depth in P/F was 50% inner enamel and 50% into the outer 1/3 dentin)	Lesion depth in P/F with 77% in dentin	Lesion depth in P/F with 88% into dentin	Lesion depth in P/F with 100% in dentin	Lesion depth in P/F 100% reaching inner 1/3 dentin

****extrinsic and intrinsic stains are code 0**

Most affected teeth (from most to least affected)

Lower molars and upper first molar →upper second molar →upper first and second premolars and lower second premolar → upper incisors → upper canines and lower first premolar→ lower incisors and canines

Q: how do incipient lesions appear clinically?

- Smooth surface: white band cervically adjacent to the gingival margin
- Proximal surface: kidney shaped white or light brown area under the contact area

> Fissures: white or stained fissure

Minerals in teeth are arranged in apatite crystals:

Hydroxyapatite (HA)= Ca10 (PO4)6 (OH) Fluorapatite (FA)= Ca10 (PO4)6 (OH.F)2

FA crystals are :

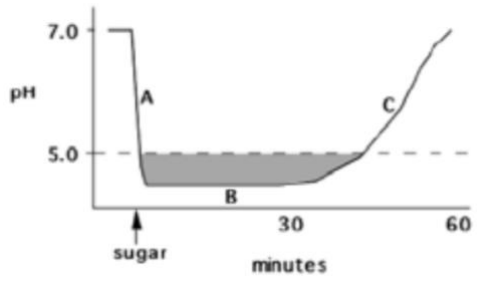
1- Less acid soluble
2- Larger and more stable
3- Have less spaces between crystals → less water + less chance of acid to diffuse through

Saliva PH = neutral 6.8 critical PH for enamel dissolution = 5.5 critical PH for FA dissolution = 4.5

Acid produced by the bacteria attacks the crystals→ remove the minerals from the surface → increases the spaces between them → tissue becomes more porous

Q: why do incipient lesions appear different when wet and when dry? Because as the acid dissolves the mineral and creates space between the crystals the space is filled with water and saliva, when you dry the surface with air the space is filled with air. Air and water have different refractive index and this is why the lesion appears differently.

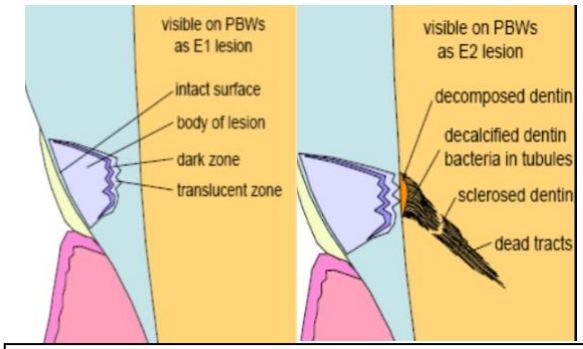
The PH curve is called the Stephan curve **



> The rapid drop in PH indicates the sugars being converted into acids overwhelming the buffering capacity of saliva.
> The plateau happens because of the catabolism (breakdown) of intracellular polysaccharides
> The rise in PH occurs due to the buffering ability of saliva

Facts:

> Caries progress slowly thorugh the enamel and quickly through the dentin
> Dentine lesions have more lactobacilli because the low PH is more steady



ENAMEL CARIES DENTINE CARIES

Q; why do we remove infected dentine and keep affected dentine?

- infected dentine has bacteria + collagen is irreversibly denatured → cannot be remineralized
- Affected dentine does not have bacteria + collagen is reversibly denatured → can be remineralized
- Tubular sclerosis = deposition of minerals in the dentinal tubules are requires the presence of vital odontoblasts

Because of different E.rod direction caries on smooth surface progress in a cone (apex towards the dentine) , on fissures also in a cone but base towards the dentine.

Radiographical classification

E0/R0	**NO RADIOLUCECNY**
E1 /RA1	**RADIOLUCECNY IN THE OUTER ½ OF ENAMEL**
E2/RA2	**RADIOLUCENCY IN THE INNER ½ OF ENAMEL**
D1 /RA3	**RADIOLUCECNY IN OUTER 3RD OF DENTINE**
D2/RB4	**RADIOLUCECNY IN MIDDLE 3RD OF DENTINE**
D3/RC5	**RADIOLUCECNY IN INNER 3RD OF DENTINE**

E1,2,D1,2,3 → NOTATION SYSTEM

R0,RA1,RA2,RA3,RB4, RC5-6 → ICCM SYSTEM

Root caries

- Cementum is thin and has little resistance to caries
- Root surface has more **carbonated petite** that crown surface
- Root caries are U shaped in cross section
- Greater space between DT and DT are shorter and straighter

Q:How can you asses the activity of the lesion? [IMP]

- **In the same session** : look for inflamed gingiva near the lesion, plaque near or on the lesion, appearance of the lesion when wet and when dry [white, rough, dull or smooth] and the pt's overall caries risk [salivary flow rate , fluoride exposure, presence of other lesions]
- **Over time**: increase in the number of lesions or change in the lesion appearance and size

TABLE 3-5 Clinical Characteristics of Normal and Altered Enamel

	HYDRATED	DESICCATED	SURFACE TEXTURE	SURFACE HARDNESS
Normal enamel	Translucent	Translucent	Smooth	Hard
Hypocalcified enamel	Opaque	Opaque	Smooth	Hard
Incipient caries	Translucent	Opaque	Smooth	Softened
Active caries	Opaque	Opaque	Cavitated	Very soft
Arrested caries	Opaque, dark	Opaque, dark	Roughened	Hard

** arrested white spot lesions are more resistant to acid attacks than sound enamel.

Q: how do you detect caries in general?

1- Visual inspection [preferably under magnification] and using air water syringe to examine surf when wet and when dry
2- Use dull probe over the surface horizontally
3- Radiographs
4- Advanced techniques like : fiber optic transillumination [FOTI] or DIFOTI or using laser [diagnodent]

NEVER USE A SHARP EXPLORER TO DETECT CARIES, IT CAN REMOVE THE PROTECTIVE ORGANIC PLUG OVER FISSURES AND INDUCE CAVITATION – THE ONLY EXCEPTION IS USING A SHARP EXPLORER TO CHECK ARRESTED LESIONS

Caries risk assessment

Caries risk = the probability of caries incidence (development of new lesions) or change in activity and size of current lesions over a period of time.

Q: how can you know the caries risk of the patient?

- history to know if the pt has any medical conditions that might lead to increased risk or is taking any medications that affect salivary flow rate or are high in sugar
- Dental and perio charting + radiographs → to know number and status of current carious lesions
- Bacterial testing → to know microbial counts
- Salivary testing → to know salivary flow rate and salivary PH
- Diet analysis → to identify factors that affect caries like frequent snacking, frequent soft drinks and high sugar intake
- Dental habits → tooth brushing, flossing (if the pt is getting adequate fluoride exposure or not)

Q: mention one bacterial test that can be done to identify caries risk? CRT bacteria (ivoclar vivadent) shows MS and LB counts

- Caries increase in prevelance with age (peak from 4-25 yo)
- Bakers, sugar cane cutters, chocolate and candy makers have higher caries prevelance

CARIES RISK	DEFINITION
LOW	No incipient, cavitated, primary or secondary lesions in the past 3 years. May have inactive white spots Low bacterial load Normal diet (low sugar intake) and normal saliva
MODERATE	**Younger than 6 YO** – no incipient, cavitated, primary, secondary lesions in the past 3 years but they have at least one factor that increases their risk [High bacterial load or reduced salivary flow rate or moderate sugar intake] **Older than 6 yo** – no incipient, cavitated , primary or secondary carious lesions in the past 3 years but at least one risk factor that increases their risk [high bacterial load , moderate sugar, reduced salivary flow rate] **OR** 1 -2 active incipient white spot lesions or cavitated primary or secondary lesions in the past 3 years.
HIGH	**Younger than 6 YO -** multiple risk factors that increases their risk OR any active white spot lesion or cavitated lesion in the past 3 years **older than 6 YO-** multiple risk factors that increases their risk **OR** 3 or more active incipient or cavitated primary or secondary white spot lesions in the past 3 years

Caries management

A. Therapeutic (non surgical)
B. Restorative (surgical)
   - Prevention is during colonization and dem / rem stages before a white spot occurs.
   - Diagnosis occurs when you can see a white spot lesion
   - Restorations are required for enamel, dentine, pulpal lesions

Arrested caries do not require treatment, treatment is only to improve aesthetics

THERAPEUTIC (NON SURGICAL)	
ANTIMICROBIALS	Cations : + ve charge → CHX and metal ions like Ca and Zn Anions : -ve charge → Fluoride containing substances Non ionic : (ex: phenol derivatives like triclosan and listerine) Mechanism of action : Interfere with bacterial membrane function and glucose uptake **CPP/ACP [MI paste and MI paste +] or [GC tooth mousse]** : casein phosphopeptides / amorphous calcium phosphate →milk derived product Mechanism of action: Stabilizes calcium + phosphate + fluoride as amorphous complexes making them available to remineralize the tooth surface. It strongly binds to the tooth and the bacteria in the plaque depositing high concentration of ACP. Under acidic conditions calcium phosphate is super saturated in plaque to inhibit demineralization and enhance remineralization. Uses: TX of dental sensitivity after bleaching, scaling and root planning. ** preventing caries is an Off – label use of CPP/ACP **CHX:** interferes with bacterial membrane function + bacterial adhesion and pellicle formation + reduces bacterial acid production **Most used form is Di – gluconate** **Available CHX forms :** mouth rinse CHX gluconate 0.12 % , gel, spray, toothpaste, periodontal dressing CHX side effects: staining , parotid gland swelling, oral mucosa desquamation, altered taste
ENZYMES	Ex: glucose oxidase and amyloglucosidase [found as added agents in toothpasts and mouthrinse] Mechanism of action = enhance lysosome activity + interfere with bacterial adhesion
SUGAR SUBSTITUTES (SUGAR ALCOHOLS)	Interfere with bacterial glycolysis Ex: xylitol, sorbitol Maltitol is 90% as sweet as sugar
VACCINES	sIgA – inhibit adherence and activity of s mutans

**antigen I/II glucosyltransferase and glucan binding proteins – main proteins that mediate attachment of bacteria [vaccines focus on this point]

Therapeutic (non surgical management):

- No cavitations → arrested caries → no tx
- No cavitation → progressive lesion → antimicrobials + FL
- Cavitation → restoration + antimicrobial + FL

Indications for restorative treatment:

1- Tooth is sensitive to hot / cold
2- Progressive caries
3- Pt cannot provide effective home care
4- Caries reaching dentine or pulp

Ozone therapy: disinfects due to oxidizing properties – removes biofilms and related microorganisms – effective in reversing root caries

P/F sealants can be:

1- Glass ionomer
2- Resin modified glass ionomer
3- Flowable composite (light or chemical cured)

Caries management by risk assessment CAMBRA

Caries Management by Risk Assessment
Clinical Guidelines for Patients Age 6 and Older

Risk Level ### ***	Frequency of Radiographs	Frequency of Caries Recall Exams	Saliva Test (Saliva Flow & Bacterial Culture)	Antibacterials Chlorhexidine Xylitol ****	Fluoride	pH Control	Calcium Phosphate Topical Supplements	Sealants (Resin-based or Glass Ionomer)
Low risk	Bitewing radiographs every 24-36 months	Every 6-12 months to re-evaluate caries risk	May be done as a base line reference for new patients	Per saliva test if done	OTC fluoride-containing toothpaste twice daily, after breakfast and at bedtime. Optional: NaF varnish if excessive root exposure or sensitivity	Not required	Not required Optional: for excessive root exposure or sensitivity	Optional or as per ICDAS sealant protocol (TABLE 2)
Moderate risk	Bitewing radiographs every 18-24 months	Every 4-6 months to re-evaluate caries risk	May be done as a base line reference for new patients or if there is suspicion of high bacterial challenge and to assess efficacy and patient cooperation	Per saliva test if done Xylitol (6-10 grams/day) gum or candies. Two tabs of gum or two candies four times daily	OTC fluoride-containing toothpaste twice daily plus: 0.05% NaF rinse daily. Initially, 1-2 app of NaF varnish; 1 app at 4-6 month recall	Not required	Not required Optional: for excessive root exposure or sensitivity	As per ICDAS sealant protocol (TABLE 2)
High risk*	Bitewing radiographs every 6-18 months or until no cavitated lesions are evident	Every 3-4 months to re-evaluate caries risk and apply fluoride varnish	Saliva flow test and bacterial culture initially and at every caries recall appt. to assess efficacy and patient cooperation	Chlorhexidine gluconate 0.12% 10 ml rinse for one minute daily for one week each month. Xylitol (6-10 grams/day) gum or candies. Two tabs of gum or two candies four times daily	1.1% NaF toothpaste twice daily instead of regular fluoride toothpaste. Optional: 0.2% NaF rinse daily (1 bottle) then OTC 0.05% NaF rinse 2X daily. Initially, 1-3 app of NaF varnish; 1 app at 3-4 month recall	Not required	Optional: Apply calcium/ phosphate paste several times daily	As per ICDAS sealant protocol (TABLE 2)
Extreme risk** (High risk plus dry mouth or special needs)	Bitewing radiographs every 6 months or until no cavitated lesions are evident	Every 3 months to re-evaluate caries risk and apply fluoride varnish.	Saliva flow test and bacterial culture initially and at every caries recall appt. to assess efficacy and patient cooperation	Chlorhexidine 0.12% (preferably CHX in water base rinse) 10 ml rinse for one minute daily for one week each month. Xylitol (6-10 grams/day) gum or candies. Two tabs of gum or two candies four times daily	1.1% NaF toothpaste twice daily instead of regular fluoride toothpaste. OTC 0.05% NaF rinse when mouth feels dry, after snacking, breakfast, and lunch. Initially, 1-3 app. NaF varnish; 1 app at 3 month recall.	Acid-neutralizing rinses as needed if mouth feels dry, after snacking, bedtime and after breakfast. Baking soda gum as needed	Required Apply calcium/ phosphate paste twice daily	As per ICDAS sealant protocol (TABLE 2)

Fluoride

Fluorine is a halogen gas – organic fluoride is bound to Carbon – inorganic is bound to metal ions (NaF)

Major source of fluoride = drinking water

Dietary sources = milk , juice, cheese non dietary sources = toothpaste, mouthrinse

When you drink fluoridated water:

Little stays in your mouth → majority goes to the stomach and GIT to be absorbed by passive diffusion and distributed in the body → excess is excreted in urine, faeces, sweat or taken up by the hard tissues (bone + teeth)

Bone stores 99% of fluoride in the body (amount of fluoride in the body varies with age)

Fluoride crosses the placenta and is found in small amounts in breast milk

Anticaries mechanisms of fluoride

- **Pre eruptive : (systemic)**
  Using fluoridated water, fluoride tablets / drops → fluoride will be incorporated into the enamel during it's formation → formation of FA crystals which are more acid resistant
- **Post eruptive : (topical)**
  Using fluoride dentifrices/ tooth pastes etc to act on tooth surface during enamel maturation or demineralization

Functions of fluoride:

1- Enhance remineralization
2- If fluoride exceeds 1000 ppm → CaF2 forms coated by calcium phosphate to retard solubility [CaF2 dissolves under acidic medium to release fluoride]
3- Fluoride replaces carbonate ions in apatite crystals [low carbonate apatite crystals are more stable]
4- Inhibit bacterial enolase activity → less acid production
5- Changes morphology of teeth making it more self cleaning (shallower and wider fissures**)**

- **Adult toothpastes contain 1000 ppm (1mg of F per 1 gram of tooth paste)**
- **Low fluoride pediatric toothpastes contain 250-600 ppm**
- **For caries prevention → low fluoride concentration**
- **Pt at high risk with multiple carious lesions → high fluoride concentration to cause remineralization**

Q: what do you need to consider before prescribing additional fluoride to a patient?

1- Age
2- Current exposure to fluoride from diet and other sources
3- Pt's caries risk + salivary flow
4- Presence of exposed roots
5- Presence of appliances or orthodontic wires
6- Pt's ability to perform oral hygiene (mental / physical disability)

** minimum fluoride exposure should be brushing twice daily with a fluoride toothpaste

Additional fluoride can be through → Increasing frequency of brushing or additional self applied gels / mouthrinses

** you should give the pt written and oral instruction on (when, how and how often should they use the additional fluoride + associated dangers) + follow up

Fluorosis higher than normal fluoride ingestion when enamel is forming – it is a qualitative defect but in severe form it becomes a quantitative defect

threshold dose at which fluorosis begins = **0.05 mg F per Kg body weight**.

Risk factors for fluorosis: infant formulas/ improper use of fluoride tablets / fluoridated water

Fluorosis index (dean's index)

Dean's index for fluorosis

Mild	White opaque areas do not involve 50% of the surface
Moderate	All surfaces are affected with brown stains and attrition surfaces show wear
Severe	All surfaces are affected , pitting and major form of the tooth is affected

Tetracycline stains → gray/ brown horizontal band of stain or can involve the entire tooth + appears on all teeth in the same degree

Q: what are commonly used fluoride mouthrinses?

Daily	Weekly
A. 2% neutral Naf	0.2% Naf (1000 ppm)
B. 0.02% APF	
C. 0.04% partially acidulated NaF	

Fluoride mouthrinses are indicated in :

1- Pts undergoing ortho tx
2- Pts with post radiation xerostomia
3- High risk children
4- Children unable to perform good oral hygiene

Contraindicated In children below 6 yo → risk of ingestion

Fluoride tablet recommended dose

	Concentration of fluoride in water		
	<0.3ppm F	0.3-0.6ppm F	>0.6ppm F
Birth -6 mo	0	0	0
6mo-3yr	0.25mg	0	0
3yr-6yr	0.50mg	0.25mg	0
6yr –to at least 16yr	1.00mg	0.50mg	0

Fluoride varnish/ gel

1- **Duraphat: 2.5 % (2500 ppm) NaF** **fluor protector = 0.8%**

- Remove only gross plaque – no need for prophylaxis because plaque will act as a reservoir for fluoride to be released when Ph is low
- Dry the teeth before application for better adhesion
- Spot applicaction for hypersensitive teeth, carious and erosive lesions

2- **APF gel : 1.23% (12,300 ppm) NaF + orthophosphoric acid + HF**

**** acidic cannot be used on exposed dentine – only used for caries prevention**

**** can discolor teeth or restorations**

3- **2.2% neutral sodium fluoride**
For enamel erosion + exposed dentine
Non irritating to the gingiva
Does not cause discoloration of teeth / restorations

4- **10% stannous fluoride (snF2)**
Used locally for at risk surfaces like pits and fissures or white spot lesions
For arresting root caries and post irradiation pts

** causes staining of teeth and restorations

Management of fluorosis:

1- **Surface remineralization**
2- **Microabraision**
3- **Restorations**

Fluoride calculations

1ml of Brand W 1.23% NaF gel

- 1.23% NaF x 1/2.2 = 0.56% F
- 0.56 x10 = 5.6mgF per 1 ml
- 5.6 x 1000 =5600ppm (ppm=milligrams per liter)

5ml of Oral B Fluoro-rinse (0.2% NaF) that a 65 year old male with root caries uses twice a week.

- 0.2% NaF compound x 1 / 2.2 = 0.09 % F ion x 10 = 0.9 mg F | ml
- 0.9 x 5ml = 4.5mg F ion x 2 / week = 9.1mg F

1ml of Brand Y 0.6% SnF_2 gel

- 0.6% SnF_2 x 1/4.1 = 0.15% F
- 0.15 x10 = 1.5mgF per 1 ml
- 1.5x 1000 =1500ppm

1ml of Brand Z 1.23% APF gel

- 1.23% APF because its APF it has 1.23% F and this is equivalent to 12,300ppm and 12.3mg F per 1ml

Probable toxic dose = 5mg F/kg of body weight

Fluoride toxicity signs:

Nausea + vomiting + diarrhea + excessive salivation + mucous discharge from nose and mouth

When it reaches lethal dose → tetany + convulusions , hypotension, arrythmias, electrolyte imbalance

A 2 yr-old child weighing 10kg swallows one tube of toothpaste (90g of a 0.76% MFP toothpaste)

- Amount of fluoride ingested: 1mg/gx90g toothpaste=90mg
- Weight of child=10kg
- Fluoride dosage ingested: 90mg/10kg= 9mg/kg bodyweight

Non carious damage to teeth

Hydrodynamic theory

- dentinal tubules are filled with fluid and odontoblastic processes + fluid
- As the dentinal tubules get exposed – movement of the dentinal fluid stimulates the odontoblastic processes → pain
- Hot / cold / sweet and sour lead to osmotic changes in dentinal fluid → fluid movement and stimulation of odontoblasts

Type	Definition	Appearance	Management
Attrition	Loss of tooth strcuture caused by tooth to tooth contact by mastication or parafunctional habits (bruxism)	Flat surfaces and wear facets on incisal and occlusal surfaces (enamel and dentine wear at the same rate)	Pt education regarding parafunctional habits like bruxism Night gaurd
Erosion	Loss of tooth structure due to chemical process (anorexia , bulimia, frequent soda , frequent vomiting and GERD, Exposure to chlorine in swimming pools)	**-Ill defined saucer shaped lesions** on the buccal/palatal surface of teeth and occlusal surf of posteriors [in case of GERD] -Raised amalgam restorations -Increased incisal translucency -Loss of surface characteristics of enamel	Diet advice to reduce consumption of acidic drinks – don't brush directly after drinking acidic drinks (chew sugar free gums to stimulate salivary flow or rinse with water) If the cause is medical → refer to a physician
Abrasion	Loss of tooth structure due to mechanical friction with a foreign object (improper tooth brushing, pens, toothpick)	V shaped notch with **smooth , polished internal angle** on buccal cervical surface of teeth (mostly canines and premolars)	Advise pt to switch to soft tooth brush + educate on proper brushing technique
Abfraction	Loss of tooth structures at cervical areas due to abnormal occlusal load causing flexure of the tooth and micro cracks cervicaly	V shaped notch with **sharp dull internal angle** on Buccal or labial surfaces of teeth (specially teeth that have excursive interferences or eccentric occlusal load)	

Difference between dental attrition, abfraction, erosion and abrasion

Attrition | Abfraction | Erosion | Abrasion

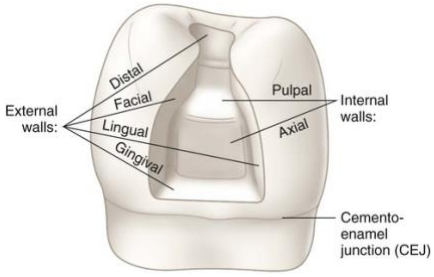
Enamel hypoplasia quantitative defect – enamel is reduced in thickness or deficient in structure causing pitting and grooves on teeth or malshapened teeth

Enamel hypomineralization qualitative defect – normal enamel deposition but reduced mineralization causing changes in color or translucency due to spaces and pores filled with water / protein not minerals [enamel is weaker → chipping of enamel]

Cavity preparations

Basics

- **Simple cavity = involves one surface only [class I]**
- **Compound = involves 2 surfaces [class II]**
- **Complex = involves 3 surfaces [class IV]**



If the cavity includes the pulp chamber then the pulpal wall will be called sub pulpal wall.

Q: **what are the objectives of any tooth preparation?**

1- Remove all defects / caries and provide protection to the pulp
2- Be as conservative as possible
3- Allow functional and aesthetic placement of restorations

Q: what are the things you should consider for any cavity ?

1- Diagnosis [pulpal and periodontal status, location of the tooth, occlusal loading on the tooth]
2- Pt's caries risk and ability to maintain OH
3- Esthetic demands/ pt preference and financial status
4- My own skills and experience
5- If you can obtain good moisture control and isolation

Q: how can you provide pulpal protection during any cavity prep?

1- Be as conservative as possible, avoid over cutting and unnecessary deepening of the cavity
2- Avoid heavy pressure with excavator or using rotary instruments while scooping out soft caries at the bottom of the cavity
3- Use new, sharp burs with intermittent light pressure and adequate water to prevent thermal irritation to the pulp
4- Apply appropriate liner/ bases in deep cavities

Q: how can you prevent caries recurrence around a restoration?

1- Remove all carious enamel and dentine and leave only affected dentine
2- Include all susceptible areas [retention grooves, pits and fissures] while still following minimal intervention concept
3- Remove all undermined enamel that is prone to fracture
4- Give the cavity margin the correct angulation according to what restoration material you are using [amalgam need 90° CSM]

Resistance form = design features that prevent fracture of both tooth and restoration [obtained by making the cavity in modified box form .

Modified box form importance:

1- The box is perpendicular to the occlusal forces → neutralize the stresses
2- Prevents splitting of the cusps
3- Provides frictional retention

4- Materials adapt better to flat walls + provide enough material thickness in all directions
5- Improves visibility and instrumentation

** modified box = provides retention and resistance

Resistance form= design features that prevent dislodgement of the material.

- Convergence is an example of retention
- Every portion of a compound cavity must have it's own retentive features otherwise → isthmus fracture

Undermined enamel = enamel that it not resting on sound dentine – **has to be removed BUT can be kept in esthetic areas with low occlusal load using adhesive restorations**.

Convenience form = design features to allow you to access and see the cavity better

NOTE: if the cavity extends to the DEJ you need to extend 0.2- 0.5 mm beyond the DEJ because:

1- To ensure that there is no more lateral spread of caries along the DEJ
2- To avoid placing a restoration where the DT anastomose and branch

Hard discolored dentine can be left because it is arrested caries [arrested caries must be removed in anterior teeth]

Q: how can you provide retention and resistance in a cavity ?

Retention	**Resistance**
1- Modified box form to provide frictional retention 2- Dove tail locks 3- Retention grooves 4- Extension to the other side [not preferable – removes sound tooth structure] 5- Pin retention [not preferable – you might expose the pulp or penetrate the gingiva if they are incorrectly placed / they conduct heat because they are metal] 6- Post and core retention in RCT teeth 7- Slots, steps, cleats 8- Micromechanical retention by adhesive restorations or using amalgam bond	Modified box allows : 1- Forces to be perpendicular 2- provides frictional retention 3- better adaptation of material + enough material thickness 4- prevent splitting of the cusps

Beveling:

- **short bevel [just involves a part of the enamel]** → cast gold restorations / resin composite
- **long bevel [from CSM to DEJ – full enamel thickness]** → cast restorations and resin composite if more retention is needed
- **hollow ground bevel** → concave grounding of the outer 2/3 of enamel to make the cavity have a butt joint
- **counter bevel** → in gold onlays

Instruments

- Regular mirrors = silvered on the inner side
- Front surface = silvered on the outer side [better don't produce double images – more clear]
- Concave mirrors are magnifying mirrors
- Each instrument has a specific formula written on the SHAFT
- Double ended instruments for right and left or mesial and distal
- Cone socket instruments =an instrument that has the shank and working end seperable from the handle [cheaper to replace, less stable – only for condensers and mirrors]
- Hand instruments are made from :
  1- Stainless steel
  2- Carbon – steel (better at keeping the cutting edge sharp)
  3- Tungsten carbide (most efficient in cutting – can rust or corrode)
- Instruments are named according to :
  1- Their function / purpose [excavator, condenser]
  2- Number of angles
  3- Way of use [push . pull]
  4- Form of the working end [hoe , hatchet]
- Contra angle = addition of one or more angles to the shank of the instrument to bring the working end 2-3 mm within the long axis of the shaft for **accessibility, stability and visibility.**
  Single plane instrument: force is applied in the same plane as the handle and blade used for direct and lateral cutting.
  Double plane instrument: force is applied at right angle to the plane of the blade and the handle used only for lateral cutting
  How can you know mesial from distal in a single beveled instrument?
  Hold the instrument with the cutting edge facing down, if you can see the bevel → distal
  If you can't see the bevel → mesial [opposite if you are looking at the inside of the instrument]
- **Only hatchets and straight chisels are bi beveled**

Instrument formula

First number	Width of the blade in one tenth of mm
Second number	Length of the blade in mm
Third number	Angle of the blade with the long access of the shaft in centigrade
Fourth number	Only present in angle formers and gingival marginal trimmers

The last separate number on the shaft of the instrument is the stock number

INSTRUMENT	USE
MIRROR	Indirect vision + retraction
EXPLORER (COW HORN, NO.17, STRAIGHT)	Determine hardness of dentine Check margins of the restoration Feel surface irregularities
PROBE	Measure dimensions of instruments To check for enamel cavitation Check depth of cavity
CHISELS	Cleave undermined enamel and shape enamel walls Enamel hatchet: cutting edge beveled in the same plane as the shank (single plane instrument) Widelstaedt chisel: a curved straight chisel
GINGIVAL MARGINAL TRIMMER	Create the bevel of the gingival floor Form sharp angles in the internal parts of the cavity
SPOON EXCAVATOR	Remove soft carious dentine
DISCOID EXCAVATOR	Remove marginal flashes of amalgam during carving
CLEOID EXCAVATOR	Remove decay from difficult areas Remove pulp chamber in endo treatment Gold and amalgam carving [creating proximal fossa and marginal ridges]
SPATULA	Mixing cements or powder and liquid
PLASTIC INSTRUMENTS	Can be made with: Aluminum – stainless steel – plastic – ivorine Plated with Teflon or titanium nitride to minimize material adhesion and facilitate cleaning Used for placing rubber dam – placing and shaping composite – placing retraction cord
CONDENSERS	Stainless steel condensers – smooth end for amalgam and rough end for gold Teflon or titanium plated condensers – for composite Small rectangular or markley's condensers – condense amalgam around pins
BURNISHERS	PKT3 – peter k Thomas to place direct tooth colored restorations Egg shaped – condensing amalgam and give intitial anatomy Ovoid burnishers – burnish the margins of gold restorations
CARVERS	Hollenback No1/2- carving amalgam and wax

Q: **how can you know that an instrument is no longer sharp? How can you sharpen it?**

1- Look at the cutting edge under bright light and magnification
2- Pull the instrument across hard plastic (if it slides → dull instrument if it cuts through → sharp)
3- Use sterilizable sharpness testing sticks
   You can sharpen it mechanically or manually using Arkansas stone at 45 ° b/w stone and the blade
   Forward and back ward strokes – for discoid and cleoid → continuous rotation against the stone at 45°

Rotary instruments

Low speed = 3,000 – 6,000 RPM **high speed = 45,000 – 100,000 RPM**

Dental burs: **head** = stainless steel or tungsten carbide **shank** = stainless steel

Stainless steel	Tungsten carbide
Used only at low speed	Generate less heat More effective cutters Longer life Expensive Brittle

Cutting burs	Finishing burs	Burnishing burs
6-8 blades	8-40 burs (higher number of blades used for fine finishing)	Smooth burs

Bur shape	Function
Round burs	Initial penetration Placing retention grooves Large round burs are used to remove carious dentine
Wheel	Gross removal of tooth structure Place grooves
Inverted cone	Cavity extension + establish wall angulations and retention forms
Cylindrical fissure bur	Smoothening cut surfaces Give proper angulation to axial walls
Pear shaped burs	Mainly used in pedo Conservative cavity preparations
End cutting burs	Extend cavity apically without axial reduction

Each bur has a number – if the bur number starts with 1 → round ended

Cutting efficieny : the ability of the bur to remove max tooth structure with minimal effort and time

Each bur has multiple blades (or teeth or flutes) – each flute has a leading side and a trailing side with an angle in between those two sides called flute angle

Clearance space = space where the chips that form during cutting collect to get eliminated

If clearance space is small → clogging + heat generation + loss of effectiveness

** a bur is considered eccentric if it's lateral displacement is more than 0.025 mm

Abrasives

Abrading particles are held by a binder - binders can be ceramic [for binding diamond particles] or electroplating using metallic binder

Abrasives	
Stones	**Discs**
Cut into enamel better than carbide **Diamond stones – to remove enamel** **Aluminum oxide – for finishing and polishing** **Granet – finishing and polishing dental appliances**	**Used mainly for finishing and polishing** **Diamond- sand- aluminmum oxide – granet – cuttle** **Rigid – for cutting (in the lab only using a straight hand piece)** **Flexible – for finishing**

Rubber abrasives

- Browni – for finishing amalgam
- Greeni – for polishing amalgam
- Super greeni – for high polishing

EVA handpiece : has in and out reciprocating movement - has special burs of flat thin flexible diamond coated files that are used to remove interproximal over hangs.

Material properties

Mechanical properties

Ideal restorative material:

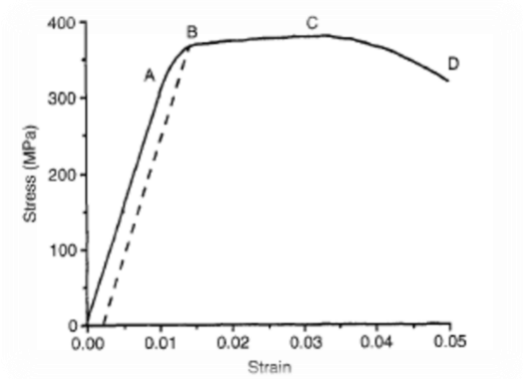
1- Biocompatible
2- Bond permanently to tooth / bone
3- Match natural appearance of tooth structure
4- Exhibit similar properties to enamel and dentine

TYPE OF FORCE	DEFINITION	DEFORMATION CAUSED
TENSION	Object subjected to two forces directed away from each other in the same straight line	Elongation – decrease in cross section
COMPRESSION	Object subjected to two forces directed towards each other in the same straight line	Shortening – increase in cross section
SHEAR	Object subjected to two forces parallel to each other	
TORSION	Twisting force	
BENDING	Bending force	

- Stress = When an external force is applied an **internal reaction** develops in the object that is **equal in magnitude but opposite in direction to the external force**
- **Stress** = internal force / area (pascal) [you can't measure stress, you measure the external force]

  1 Pa= 1 N/m^2 or mega pascals = 10^6 pascal

- **Strain** = change in the size of the material that occurs in response to force
  Strain = deformation / original length



Elastic modulus [young's modulus] = measure's the elasticity of the material – represents stiffness of the material within the elastic range (variable = E)

Elastic modulus = stress/ strain (pascal)

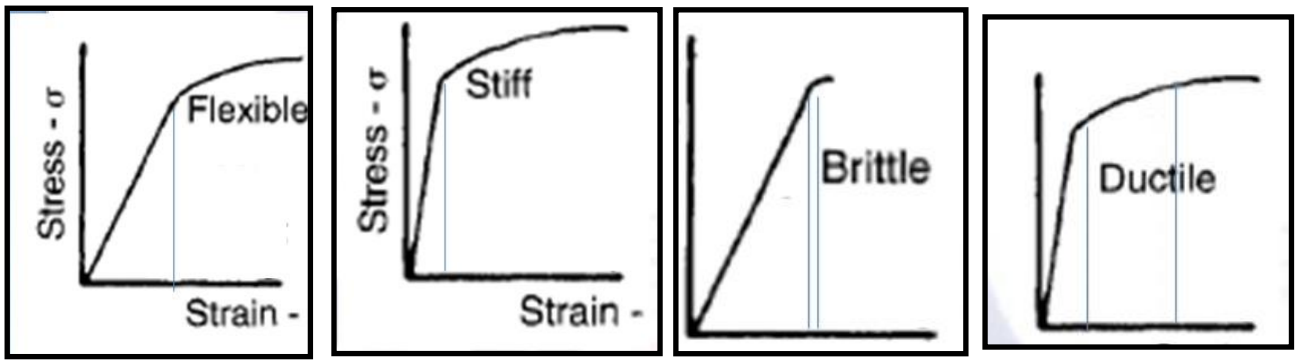
Calculated by finding the slope of elastic region

Stress/ strain curve:

- **Proportional limit [A]=** greatest stress that the material can sustain without deviation from the linear proportion b/w stress and strain.
- The area below the proportional limit is the elastic region [no perm. Deformation]
- Any force above the proportional limit will result in perm deformation.
- Area after the proportional limit = plastic region
- Elastic limit = max stress without perm deformation (occurs little bit after proportional limit)
- **Yield stress/ strength [B]** = stress at which the material begins to function in plastic manner. [limited perm deformation has occurred]
- Stress equal or greater than yield stress → functional failure
- **Ultimate strength [C]=** max stress before failure
- **Fracture strength [D]=** stress at which the material fractures

Resilience = resistance of the material to perm deformation [the area under the elastic portion]

Toughness = resistance to fracture [area under elastic and plastic portion]
Elongation = deformation that results from tension = increase in length / original length X 100
Gives an idea about the workability of the alloy
Ductility= ability of the material to be plastically deformed into a wire – by being subjected to tensile forces)
Malleability = ability of the material to be hammered or rolled into sheets by being subjected to compressive forces
Brittle material = materials that fracture when subjected to stress



Stifness = how easy it is to bend a material without causing fracture or perm deformation

Brittle material = little ability to deform

Elastic modulus of enamel is 3 times more than dentine (enamel is brittle , dentine is flexible)

Flexural strength = bending strength = ability to resist deformation under load

Fatigue strength = stress at which material fails under **repeated loading**

Hardness = resistance to surface indentation or penetration (measure by hardness number)

High hardness number = hard material

Physical properties

- **Density = mass per unit volume (gram / cm^3) or (lb/in^3)**

Highest to lowest density (metals – ceramics- polymers)

- **Thermal conductivity= rate of heat conduction**
- **Thermal diffusivity =amount of heat conduction per unit time.**
- **Thermal coefficient of expansion or contraction:** change in length per unit length of the material as 1°C change in temp.

$$\alpha = \frac{\text{L final- L original}}{\text{L original x (°C final- °C original)}}$$

** close matching between the coefficient of thermal expansion is imp b/w the tooth and the restorative material to prevent marginal leakage, recurrent caries, discoloration, sensitivity

Specific heat = the amount of heat needed to raise the temp of 1 gram of a material 1°C - metals have low specific heat, non metals have high specific heat **(prolonged heating for metals is not necessary)**

- **Heat of fusion**: amount of heat required to change one gram of a material from solid to liquid state at melting temp.
- **Latent heat of fusion:** When the material is in a liquid state – heat of fusion is retained in the liquid but when it becomes solid the heat is liberated.
- **Electrical conductivity:** relative rate of electron transfer through a material
- **Water sorption**: amount of water **adsorbed** onto the surface and **absorbed** into the body of the material
- **Contact angle**: the angle that a drop of liquid makes on the surface it rests on .
  - Small contact angle → good wetting
  - Contact angle approaching 90 → poor wetting
  - Contact angle approaching 180 → no wetting
- **Plasticity** = the material is permanently deformed under force.

Optical properties

- **Transmission: l**ight passing through an object without attenuation
- **Transparency** : light passing through an object without distortion
- **Translucency** : some light passes without distortion and some get reflected or scattered
- **Opacity**: a material that prevents the passage of light (absorbs all of the light)

Smooth surface =specular reflection (angle of incidence – angle of reflection) → glossy appearance

Rough surface= diffuse reflection → dull apearance

Refraction= change in the direction of light entering a second medium [if there is large difference in the refractive index of the material and the tooth → opaque appearance]

Scattering= the original light is weakened by being scattered in a direction away from the observer's eyes. [opacifiers, pigments and voids act as scattering centers to increase the opacity of the material]

- Hue = the dominant wavelength – the color of the material
- Chroma= intensity or strength of the color
- Value = the degree of lightness or darkness [related to the vitality of teeth]

  Low value = dark color high value = light color

Biological properties

- Primary bonding = bonding through chemical and electrochemical bonds
- Secondary bonding = changes during absorption and adsorption
- Solubility = ability of a material to dissolve itself in a fluid
- Adsorption = adding molecules to a surface by secondary bonding
- Absorption= penetration of molecules into a solid by diffusion
- Cytotoxicity = the ability of a material to induce injury to a cell, organ or tissue
- Carcinogenicity = ability of a material to induce cancer

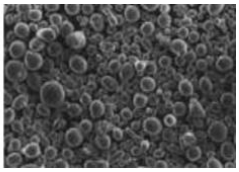
Dental materials

Dental amalgam

- Amalgam = an alloy of mercury, silver [highest percentage] , tin, copper, zinc
- Both silver and copper are imp because they decrease flow and creep of amalgam restorations
- Zinc = scavenger for oxides → reduces corrosion , but causes delayed expansion of amalgam when contaminated with water or saliva

Amalgam is classified according to :

1- **Composition:**
   A. **High copper amalgam :**
      Uni compositional = all are spherical particles of same composition – requires the least mercury
      Admixed= irregular [lathe cut] + spherical particles of same or different composition
   B. **Low copper amalgam :** irregular or spherical particles
2- **Particle shape:**
   A. **Lathe cut** – irregular shaped particles → greater spaces between particles → this space is filled with mercury
   B. **Spherica**l – small spherical particles → smaller spaces between particles → less mercury is needed



Q: which type of amalgam needs greater condensation forces ? Lathe cut because you need more forces to get rid of the excess mercury in between the particles

- Strongest phase when amalgam is mixed = Gamma phase Ag3Sn (unreacted phase)
- Gamma 2 phase must eliminated because it is weak and will weaken the amalgam mix [increases corrosion + fracture]

Most of the amalgam in the market is either uni compositional [spherical] or Admixed

Mercury is toxic and it weakens the restoration . mercury is reduced by condensing the amalgam properly to drive the excess mercury towards the surface layer that will later be removed by carving

Corrosion: pitting and roughening of amalgam surface caused by electrochemical destruction of the amalgam – needs a conductive medium like saliva + electron difference between the parts of the restoration to cause the electrical reaction

Types of corrosion

1- **Tarnish corrosion**: because of exposure to humidity and creation of oxide particles on the surface
2- **Stress corrosion**: areas under stress have different charge than other areas → change in electrical current → corrosion

3- **Crevice corrosion**: after setting amalgam shrinks creating a gap → the fluid at the bottom has diff oxygen concentration than the surface → electrical current → corrosion → self sealing ability of amalgam to close marginal gaps
4- **Glavanic corrosion** : contact between 2 different metallic restorations , or b/w old and new amalgam / polished and unpolished amalgam

Amalgam has Coefficient of thermal expansion twice as much as tooth structure → stresses and gaps on the margins

Marginal percolation: cyclic ingress and egress of fluid at the margins of an amalgam restoration due to change in intraoral temp

Creep / fatigue: deformation that occurs in amalgam as a response to cyclic stress below fracture limit [mostly in low copper amalgams]

Amalgam will not retain it's normal anatomy → overflows over the margins → creates overhangs on the margins → stress on the overhangs will fracture the margins [marginal ditches] + recurrent caries

Mercuroscopic expansion: Excess mercury that is not removed will keep on reacting with the amalgam → weakens the restoration

Hygroscopic expansion: when there is moisture during amalgam titration or condensation → reacts with Zn releasing Hydrogen and causing delayed expansion of amalgam after few days + the gas will form bubbles on the surface of amalgam

Amalgam has high compressive strength and low tensile strength → brittle material that fractures easily [therefore the depth of cavity prep should be 1.5- 2 mm to provide enough thickness of the material]

Internal surfaces of the cavity should be smooth and with round edges to avoid sharp angles that can act as stress concentration areas and lead to crack formation and fracture

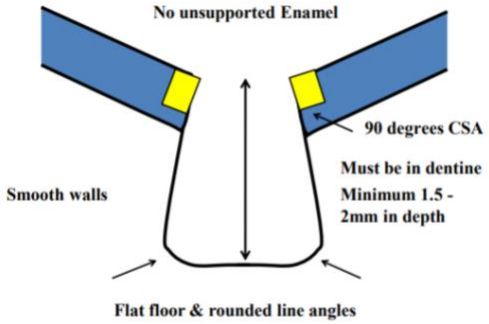
Amalgam advantages	Amalgam disadvantages
1- Self sealing ability	1- Low tensile strength [brittle material]
2- Cheap	2- Poor esthetics
3- High compressive strength	3- Thermal and electrical conductivity
4- Biocompatible	4- Flow and creep
5- Can maintain high surface polish	5- Dimensional changes

Amalgam is best used in class 1- moderate depth [should not be used if close to the pulp because of thermal and electrical conductivity]

After cavity prep apply the cavity varnish on the walls and floor to seal the dentinal tubules against the corrosive products – the varnish will dissolve over time but the gaps will be sealed by the self sealing ability of amalgam

Amalgam is ideal for large posterior restorations that will need cusp capping and are subjected to high compressive stress

- Floor should be perpendicular to the stresses
- In cusp capping – anatomical cusp reduction of 2 mm



Isthmus area:

- Isthmus width should be ¼ - 1/3 the intercuspal width
- Beveled axio- pulpal line angle to provide bulk of material and prevent stress concentration in this area
- In class II – every portion of the cavity should have it's own retention features

What is the acceptable level of mercury in amalgam? 47%

Old amaglam used to come in either powder or tablets that are crushed and mixed with mercury then the excess mercury is removed by squeezing a piece of gauze

Preweighted capsules have the correct amount of alloy and mercury

Spherical particle amalgam	Lathe cut amalgam
Easier to condense – less condensation force is needed	Harder to condense – more force is needed
Less mercury is needed	More mercury is needed
Particles slide easily against each other → better fluidity	Particles resist sliding against each other → less fluidity
Used in cavities that don't need a lot of condensation and better flow → deep cavities , amalgam pins	Used in cases that need a lot of condensation → cusp capping , large restorations that need proper contact + contour

Titration = mixing amalgam with mercury (either manually or by amalgamator)

2 factors that control titration = RPM + time

- **Under titration** → sandy dry non coherent mass
- **Over titration** → shiny , hot , sticky coherent mass , short working time
- **Proper titration** → shiny, smooth and homogeneous mass

Placement of amalgam should be completed within 3 minutes of the mix

Amalgam is placed in increments to :

- Avoid voids
- Provide maximum adaptation

- Remove all excess mercury

Moisture contamination to prevent → delayed expansion after few days and corrosion

Q: if you mixed amalgam 5 minutes ago → discard and mix a new one

In class II restorations → you fill the proximal portion first with condensation directed against cavity walls, line and point angles.

Q: how do you know that is enough force of condensation? The surface of the increment becomes soft [due to mercury release] and you hear squeezing sound.

The cavity must be overfilled to allow proper carving

Q: why do we carving? To re create the normal anatomy of the tooth surface, ensuring efficient mastication and tooth function + remove the superficial layer of excess mercury

- Carving is done when amalgam starts to set [initial setting] – when there is slight resistance to the carver
- Carving should be done from tooth surface towards the amalgam parallel to the CSM
- Early carving or carving from amalgam to tooth → creates sub margins and exposes CSM

Double burnishing = you burnish twice before and after carving

Q: why do we burnish before carving?

1. **To create frictional heat to attract the mercury to the surface**
2. **Increase amalgam adaptation to the walls and margins**

Before removing the matrix band – marginal ridge and embrasures should be carved to a 45° to avoid fracture of the marginal ridge during matrix removal – matrix band should be removed in buccal or lingual direction not occlusal direction.

Supplemental grooves on the margins should be carved with probe to prevent amalgam flashes from creating marginal ditches under stress.

Post carving burnish to smoothen amalgam

Ask the pt not to chew or bit on the side of the restoration for 24 hours to prevent fracture of the restoration and to come after 24 hours for finishing and polishing of amalgam

Finishing of amalgam:

1. Removes marginal flashes [stress concentration areas] → makes amalgam stronger
2. Increase corrosion resistance
3. Decrease plaque accumulation

Finishing done after 24 hours using finishing carbide burs (12 bladed) from tooth surface to amalgam – polishing with pumice and rubber cup/ brush [avoid heat generation – this will attract the mercury to the surface and weaken the restoration]

- Amalgam crying = resistance of amalgam during carving

- Extracted teeth with amalgam restorations → should cold disinfected then discarded as hazardous waste
- If you need to remove a previously placed amalgam restoration → section it into pieces then remove them separately

Cements

Cement Function: Fill the space between restorative material and tooth preparation and enhance the resistance to restoration dislodgement

Most Common Cause of restoration failure: Loss of retention

Luting: micromechanical locking
Bond: chemical or physical interaction occurs to both surfaces that to be attracted

Provisional Cement		Definitive Cement	
Calcium Hydroxide	Zinc Oxide (Eugenol or other)	Luting Cement	Bonding Cement
		○ zinc phosphate cement ○ zinc polycarboxylate cement ○ conventional glass-ionomer cement ○ resin-modified glass-ionomer cement	○ Resin Composite Total Etch/ Self Etch/ Self Adhesive

- **Zinc phosphate = Zinc oxide + phosphoric acid**
- **Zinc polycarboxylate = zinc oxide + polyacrylic acid**
- **Glass ionomer = Flouroamino silicate [FAS] + poly acrylic acid**
- **Silicate cement = flouroamino silicate + phosphoric acid**

ZINC OXIDE EUGENOL

- Inhibition on the polymerization
- High film thickness
- Reduces bonding strength of resin cement (definitive) → use eugenol free
- Bonding strength of self-adhesive resin cement remained unchanged

ZINC PHOSPHATE CEMENT

- moderate compressive strength, ↓ tensile, Î solubility
- low pH of 2 at mix, then Î to 5.5.after 24 hrs
- Gold Standard
- lack chemical bond to tooth structure
- no pulpal irritation unless bacteria left on the prepared tooth surface
- tooth preparation with low Residual Dentin Thickness (RDT) may suffer from sensitivity during and after

ZINC POLYCARBOXYLATE CEMENT

- chemical bond to tooth structure
- biocompatibility with the dental pulp coz of Rapid Î of PH and ↓ tubular penetration

- ↓ post cementation sensitivity for teeth with low RDT
- weak bond to enamel / weaker bond to dentin *(interaction of free carboxylic acid groups with calcium from tooth structure)*
- ↓ compressive and ↓ tensile
- significant plastic deformation under dynamic loading after set→ Thus USED for **single unit restoration or short span fixed partial denture cementation**

GLASS IONOMER CEMENT

- Release fluoride (silicate cement) + Adheres to enamel & some extent to dentin (polycarboxylate cement)
- ↓bonding strength to tooth structure, moderate compressive, ↓tensile strength
- Physical properties depends on the mix ratio
- Material at the restoration margins should be protected with a coating agent (Vaseline)
- Constant long-term fluoride release and its fluoride recharging ability
- 24 Hrs to harden
- Dry Dentin → ↓ bond &post-cementation sensitivity→Thus **dry with cotton before cementing**.
- Susceptibility to moisture contamination and desiccation during the initial setting
- Early exposure to water and saliva contamination Î solubility and decrease the ultimate hardness
- ↓resistance to acid attack and bleaching→Not for patients who have gastric reflux problems or want bleaching

RESIN MODIFIED GIC

- Overcomes post cementation sensitivity to early moisture contamination and has low solubility
- High levels of fluoride release
  Moderate bonding strength, good compressive strength and tensile strength
  Chemical and polymerization setting
- Polymer degradation overtime

RESIN CEMENT

- Î compressive/tensile/bonding strength, ↓ solubility, Î esthetics
- May have ytterbium trifluoride or barium aluminum fluorosilicate filler capable of releasing fluoride after setting stage.
- Tooth-like translucency/ Tooth shades available/
- Polymerization Setting
- For cases concerned with retention, weak restoration, aesthetic restorations.
- Self-cured and dual-cured resin cements can be used for all cementation applications
- Light-cured resin cements limited to porcelain veneers and glass-ceramic restorations that allow the curing light to penetrate the porcelain
- dual-cured→ ↓ bonding strength and microhardness without curing light
- Polymer degradation overtime :

  [Dentin has MMPs, activated during bonding→ ↓ bond stability over time]

  [Pretreatment of Dentin with CHX or CHX+ Bonding agents may help]

- Self adhesive : contain 10-MDP + phosphoric acid
- Non self adhesive: you need to etch before placing

Total-Etch (Etch and Rinse)	Self-Etch	Self-Adhesive
1) acid etching, rinse, gently dried; 2) bonding agents applied, cured; 3) resin cement applied, cured.	1) and 2) are replaced with the self-etch bonding agent application, which combines the conditioner, primer, and adhesive	Does not require surface pretreatment and bonding agents (resin cement)
conventional resin cement		↓ technique sensitivity

APPLICATION

- If adequate tooth preparation and resistance form exists or where moisture control may be problems, conventional dental cements might be a better choice compared to resin cement.
-Polycrystalline ceramics are most popular for superior performance; uses GIC or Zinc Phosphate conventionally. Resin cement can work well too with a pre-use of primer (10-methacryloyloxydecyldihydrogen phosphate (MDP)) for better retention.

-For implant supported restorations, determined by retention longevity and amount. If ideally placed, use GIC or Resin cement.

Restoration type	Indicated	Contraindicated
All-metal/PFM crowns	1,2,3	4,5
Short span fixed partial denture	1,2,3,4,5	-
Long span fixed partial denture	3,4,5	1,2
Traditional feldspathic or pressable all-ceramic restorations	4,5	1,2,3
Almuina/Zirconium-based all-ceramic restorations	1,2,3,4,5	-
Metal post and core	1,2,3	4,5
Fiber post	4,5	1,2,3
Maryland bridge	4,5	1,2,3
Composite/porcelain veneer	4,5	1,2,3

1. **Zinc phosphate cement**
2. **Conventional glass-ionomer cement**
3. **Resin-modified glass-ionomer cement**
4. **Conventional resin cement**
5. **Self-adhesive resin cement**

Glass ionomer cement

Powder = calcium flouro amino silicate glass

Liquid = polyacrylic acid + tartaric acid + water **(water is needed for the rxn) [too much water – weak GIC , too little- inadequate rxn**

Q: which component of GIC affects the working time? Tartaric acid [increases working time and decreases setting time]

Strontium – based GIC = strontium is added to enhance radio opacity [ex: Fuji 9]

GIC PROBLEM = shelf life polyacrylic acid undergoes gelling effect

Q: how can you prolong the shelf life of GIC? Either use other alkenoic acids or use freeze dried poly acrylic acid.

** in case it was freeze dried poly acrylic acid it would be one bottle of powder + one bottle of distilled water

Q: what is water mixed GIC? A type of GIC that uses freeze dried poly acrylic acid

Q:How does GIC bind to tooth ? chemically the low PH attack the periphery of the silicate particles releasing the Flouride, calcium and aluminum , the carboxyl groups bind to the calcium in the hydroxy appetite crystal in the enamel and dentine. [GIC BONDS CHEMICALLY TO THE TOOTH]

GIC has 2 reactions:

- Primary reaction – the acid attacks the FAS particles releasing Ca.
- Secondary reaction- after 24-72 hours calcium is replaced by aluminum making the mix stronger

Q: why does GIC become stronger after 72 hours? Because calcium gets replaced by aluminum making a stronger cross linked matrix

When GIC absorbs water [ex: saliva from pt's mouth]→ becomes translucent and weaker

When GIC loses water [ex: working without water] → becomes more opaque and starts to shrink and crack

You need to protect GIC by applying petroleum Gel or unfilled resin (light cured)

GIC Classification

Type I	**Luting cement**
Type II	Filling material
Type III	Liner
Type IV	Fissure sealant
Type V	Ortho cement
Type VI	Core build up

- **GIC disadvantages** = poor wear resistance, low compressive strength, poor esthetics [very opaque]

- **GIC advantages**= Flouride release [anti cariogenic effect] , and fluoride recharge [the fluoride content of the GIC will be recharged everytime the pt brushes their teeth or uses a fluoride mouthwash]
- Fluoride release is highest in the first 2-3 days then it decreases

Q: how can you increase the strength of GIC?

- **Metal modified GIC :** mechanical properties did not significantly improve+ material turns greyish
  A. Admixed amalgam + GIC powder [called miracle mix]
  B. Silver metal particles added to GIC glass [called cermet , ketac silver]
- **Resin modified GIC - RMGIC :** better strength , reduced moisture sensitivity and better translucency
  (HEMA is added to the GIC liquid and/ or modify poly acrylic acid by adding methacrylate groups)
  Has 2 setting reactions [resin polymerization + acid base reaction of GIC]

Compomers = (resin + fluoride releasing glass filler) – THEY ARE NOT GIC, THEY DON'T BOND CHEMICALLY AND REQUIRE ETCHING, BONDING + LIGHT CURING

The only exception to not coating GIC is if you are using it in the control phase- if you coat it it will not release fluoride

Giomers = (pre reacted glass ionomer [PRG] incorporated inside resin matrix) – they need their own adhesive systems [glass – ionomer based adhesives]

The pre reacted glass ionomer can be:

A. Surface only [S-PRG] – any class – EX: Beautifill with Imperva FL bond (two step self etch adhesive)
B. Entire particle [F-PRG] – for cervical caries only – EX: Reactmer with reactmer bond (one step self etch adhesive)

Giomers fluoride release is more than compomers and less than GIC

Nano- ionomers : RMGIC with nano filled technology (same Flouride release as RMGIC but better polishability and translucency) [ex: Ketac Nano]

If you are using GIC under composite – you just etch the walls not the GIC with SELF – ETCH ADHESIVE [DON'T USE TOTAL ETCH OVER GIC BASE]

Tooth surface before GIC has to be pre conditioned with polyacrylic acid 10% for 10 seconds.

Don't over dry the cavity → this will lead to Post op Hypersensitivity [POH]

- GIC should be applied in the cavity before it loses it's GLOSS
- Direct injection of GIC form capsules → prevents voids
- Manipulate using plastic instrument coated with lubricant [to avoid GIC sticking]
- Immediate excess removal of GIC is done by surgical blade – final finishing is after 24 hours
- Any time you adjust the surface of GIC coat it with lubricant or unfiled resin

Resin composite

Composite = mixing 2 or more materials with different properties to get a material that has the properties of both materials

types of acrylic resin :

- MMA = methyl methacrylate
- PMMA = polymethylmethacrylate
- UDMA
- BIS -GMA
- TEGDMA

Bowen's resin [BIS-GMA] – bi functional monomer [very viscous so they added to it TEGDMA and UDMA to lower it's viscosity].

Coupling agent = a bi functional monomer that binds to the silicate portion of the filler and the resin polymer to ensure stress transfer between the phases occurs

Chemical cured composites	Light cured composites
Self cured **Activated by aromatic amines which cause bulk discoloration later on [after 3-5 years of intraoral use]**	Activated by camphroquinine – causes yellowing of composite Whiter shades of composite contain another activator not camphroquinine Marginal discoloration
Voids + uncontrolled polymerization	No voids + rapid polymerization on demand Exposed material should be covered to prevent premature curing from other light sources

Dual curing resin : has both light cured activators (initial rapid polymerization) + chemical cured activators (slower polymerization) – made to be used under opaque restorations

- Adding metal oxides → different shades of composite
- Adding titanium / aluminium oxide → lighter shades of composite
- Toluene = inhibitor to prevent spontaneous polymerization

When curing the composite the Light curing unit [LCU] should be directly perpendicular to the cavity to avoid divergence + the LCU should not be very far from the cavity [because the light is not collimated → diverge from the source → decreases in light intensity reaching the composite → no proper curing

Factors that affect composite curing:

1- Light source [intensity and wavelength]
2- Tip contamination with resin [happens when the tip touches the composite before it cures]
3- Tip size [small tip → higher intensity → better]

4- Distance b/w LCU and composite + direction of light [distance should be small + tip should be perpendicular to the cavity]
5- Size and shade of the restoration [larger and darker composites → more time is needed]

Degree of conversion = how much monomer changes into polymer

- High degree of conversion → most of the monomer reacted → weakens the composite making it softer and easier to stain

Depth of cure = the thickness of the composite that will be adequately cured (5 mm in translucent shades and 1.5 mm in darker shades]

Ideally use 2 mm increments of composite to achieve proper curing

Unreacted monomers [in deep cavities]

- can leach into the DT → pulp irritation
- may swell and plasticize

Composite types according to particle size

1- **Macro filled:** good physical properties but produce rough surfaces- difficult to finish – easily stained
** the filler are large irregular particles → during finishing they can be plucked out leaving irregular surface that is rough and easily stained
2- **Micro filled:** smoother and better ability to polish but weaker
3- **Hybrid composites:** contain small and large fillers
Small fillers giver the good polishing ability + fill up the space between the large fillers → increases strength of the composite
4- **Micro hybrid:**
5- **Nanohybrid:** nano sized particles [to provide best polish] + clusters of nano particles [to provide strength]
Both nano particles and nano cluster wear at the same time.
Provides best polish and as strong as the tooth

As the resin % increases → more polymerization shrinkage + less wear resistance + weaker composite

All purpose composites = have the highest flexural strength

Packable and hybrid composites = similar properties

Classification of composites according to viscosity

Packable	Flowable
More filler content less shrinkage **More wear resistance** **Stronger**	Less filler content [more resin] **higher polymerization shrinkage** Less wear resistance Weaker • Used in minimal class I or adaptation of proximal boxes

Applying flowable composite at the floor of the cavity → better adaptation into the floor of tha cavity, line angles etc.

Silorane based composites: has network polymerization not linear polymerization → provides least shrinkage . [not used because – very expensive + require their own bonding agents]

NOTE: Resin composites are contraindicated in high risk pts → they easily dissolve releasing cytotoxic materials

Oxygen inhibition layer: Few microns of uncured resin on the surface – because oxygen inhibits the polymerization of the free radical

- Importance : the uncured surface of one increment of composite will allow another increment to bind to it
- On the outermost layer of composite it might be eliminated by finishing and polishing or by applying water based lubricant and curing it.
- In posterior teeth = oxygen inhibition layer is removed by chewing
- In anterior teeth = by finishing and polishing to prevent staining

Antibacterial composites: used MDPB monomer – used to prevent recurrent caries under restorations or when the situation prevents complete caries removal

Best restoration of proximal contact→ packable composite + pre contoured sectional matrix with ring clamp

Reflecting clear tips : tips on the LCU that can be placed inside the deep proximal box and ensure delivery of light to the deepest portion → proper curing + they ensure proper adaptation of the matrix band to the adjacent tooth

C- factor = bonded/ non bonded surface area

- Unbonded surfaces → dissipate stress
- C – factor should be as low as possible
- Class 1 → highest c- factor class 5 = lowest C - factor

Composite advantages	Composite disadvantages
1- Esthetic **2- Conservative** **3- Low thermal conductivity** **4- Reinforces tooth structure because of adhesion** **5- No corrosion**	**1- Polymerization shrinkage** **2- Technique sensitive** **3- High coefficient of thermal expansion** **4- No anti cariogenic effect** 5- **Residual monomers can cause pulpal irritation**

Composite contraindications:

1- High risk pts
2- Areas that can't be properly isolated

3- In areas with high compressive forces or if all forces will be on composite and not shared with the tooth structure

Clinical considerations in composite restorations:

Most shrinkage stress develops after gel point is reached [after significant cross linking has occurred]

- Resin bonded to fillers → internal constraint to flow
- Composite bonded to cavity walls → external constraint to flow

Stress occurs at the bonded interfaces

- Each filler is covered by a layer of silane coupling agent to connect it with the resin matrix
- Resin matrix tries to shrink but the fillers prevent shrinkage → internal stresses generate around the filler

Q: **what are the effects of polymerization shrinkage?**

If the bonding was good → polymerization shrinkage causes cuspal deflection [stressed tooth syndrome] + cervical micro cracks

If the bonding was not very good → debonding → marginal leakage +

- Hypersensitivity
- Recurrent caries + pulpal involvement
- Marginal discoloration

Q: **what causes microleakage?**

1- Poor isolation → surface contamination → Poor adhesion and bonding
2- Hybrid layer disintegration by the DT fluid
3- Cycling changes in temp → stress at the bonded interface [due to mismatch b/w coefficient of thermal expansion b/w tooth and composite
   - Amalgam has coefficient of thermal expansion X2 compared to tooth
   - Composite has coefficient of thermal expansion X4 compared to tooth

Shrinkage occurs towards the bonded walls regardless of the direction of the light , but the area closer to the light hardens first→ the area far from the light flows towards the hardened area

Q: how can you reduce polymerization shrinkage of composite? IMPORTANT

1- Use low shrinkage composites like silorane based composites or higher filler loading [packable composites]
   Or use BULK FILL composite [less polymerization shrinkage , easier handelling, better adaptation to cavity walls , can be placed in large increments up to 4 mm]
2- Decrease the c- factor by Increasing the number of unbonded surfaces and decreasing the number of bonded surfaces. [unbonded surface will allow the material to flow and will dissipate the stresses]
3- Place composite in small oblique increments [better adaptation and curing, less voids and less shrinkage]

4- Delayed light application [expose for 2 seconds then delay for 5 mins then expose for 60 sec] – this allows the polymer to relax and flow to relieve the stress
5- Use elastic liners [filled resin adhesive system]
6- Preheating composite [less microleakage , reduces it's viscosity → better adaptation to the cavity walls , heating will allow the composite to flow and compensate for the shrinkage]

Using flowable composite or RMGIC under packable composite will increase shrinkage at the adhesive interface

Bulk fill: flowable / non flowable

- Low polymerization shrinkage and stress
- You can place large increments up to 4 mm
- Better adaptability to cavities
- Viscosity is modified for easier handling

Q: what is the importance of beveling the CSA in composite restorations ?

1- Increase the surface area for etching by exposing the ends of the E. rods and not the sides
2- Better esthetics – close matching between the composite and the tooth structure
3- Protect marginal enamel

Intermediary material [Liners and bases]

- Liners: thin materials applied to seal the dentinal tubules [only biological and chemical protection – applied in micro meters]
- Bases : thicker materials that seal the DT [provide mechanical + thermal protection] – applied in mm

Most effective barrier against irritation = sound dentine

Requirements of intermediary materials:

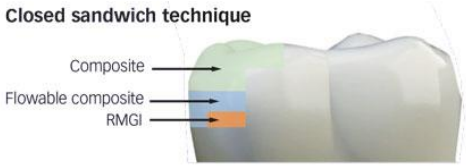
1- Provide marginal seal
2- Provide sedative action to the pulp
3- Provide thermal and electrical protection
4- Provide enough strength when applied in thin films
5- Should not interfere with the setting of other restorative materials

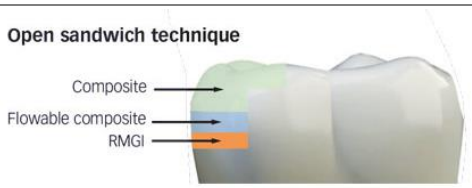
Irritation:

- Biological = bacterial leakage
- Chemical =restorative material remenants [acids, mercury]
- Mechanical = condensation / mastication forces
- Thermal= either when the material sets it releases heat or the material conducts heat

- Glutardehyade can be used as a liner to reduce sensitivity before etching
- Liners and bases should only be placed on the pulpal floor and not on the cavity walls - because they dissolve in oral fluids

Closed sandwich technique	Open sandwich technique
You placed GIC in an area that has no contact with the CSM of the prep then cover it with composite Indicated if you still have enamel at the gingival margin	You placed GIC in an area that has no contact with the CSM of the prep then placed composite without covering the GIC Indicated if you don't have enamel at the gingival margin and the cavity extended beyond CEJ





Liners	Bases
1. Solution liners: A. **cavity varnish / copal varnish** Solution that penetrates and seals the DT, when air dried the solvent will evaporate leaving thin section of resin inside the DT **Used under-** gold /amalgam restorations Under zinc phosphate cement **Contraindication-** **Under composite :** it will interfere with bond and retard polymerization **Under GIC and zinc polycarboxylate:** it will interfere with the chemical bonding of these materials **Provides only chemical and biological protection** **You apply multiple layers of the varnish – DON'T CURE** **B. dentine sealers: GLUMA –** under metallic restorations **/**GIC/ composite **[applied after etching before bonding to seal the DT]** **reduces sensitivity by sealing the DT** C. **bonding systems :** also seal DT **2. suspension liners:** **aqeous calcium hydroxide or ZOE– slightly thicker than solution liners** **3. cement liners:** **calcium hydroxide [dycal] / ZOE** relief pulpal inflammation and provide dentine bridge formation slightly thicker than suspension liners **GIC and RMGIC :** can be used as a liner , can be applied over indirect pulp capping by calcium hydroxide [dycal]	**1. calcium hydroxide cement** has high PH to stimulate reparative dentine formation + reduce pulpal inflammation **very soluble** low compressive strength → cannot be used under amalgam because it will break when you do condensation used in: • direct / indirect pulp capping • RDT less than 0.5 mm • Relieve pulpal inflammation **2. ZOE cement** Eugenol has sedative + anti inflammatory effect on the pulp [but should not contact it directly] Used as TF and to enhance pulp healing **Contraindication:** • Very deep cavities with RDT less than 0.5 • As pulp capping material • With composites or resin cements 3. **Zinc phosphate** **Exothermic setting reaction→ irritating to the pulp – setting reaction can be made faster by adding water or by increasing the temp** To increase the setting time : • Reduce P/L ration • Mix on cold slab • Mix in increments **Contra indictaed : when RDT is very thin** **4. Zinc poly carboxylate** Increase setting time : by mixing on cold slab or cooling the powder [don't cool the liquid – it will make it viscous] ** has high molecular weight – does not penetrate DT ** can't be used under ZOE or cavity varnish – interfers with their setting rxn **5. Glass ionomer cement** **6. MTA [hydrophilic - high compressive strength – good sealing ability – high PH → antimicrobial effect]** **Needs long setting time [4 hours]** **7. Biodentine [GI + MTA]**

Order of placement of materials:

1- Calcium hydroxide [in direct tooth contact]	**1- Calcium hydroxide**
2- Varnish [to protect CaoH and seal DT]	**2- GIC**
3- Zinc phosphate cement [base]	**3- Varnish**
4- Amalgam	**4- Amalgam**

Adhesion to enamel and dentine

Importance of adhesion:

1- Reinforce tooth structure
2- Conservation of tooth structure
3- Better retention of restorations

Terms & concepts:

- Absorption = molecules being taken up by another substance [included in the volume]
- Adsorption= molecules adhere onto the surface
- Cohesion = force of attraction between similar bodies
- Adhesion = force of attraction b/w dissimilar bodies

AdherenT = composite adherenD= tooth surface

- High surface energy [metals, HA] – adsorb molecules more easily
- Low surface energy [wax, Collagen] – less adsorption
- Dentin has both high surface energy [HA] + low surface energy [collagen]
- Contact angle determines the degree of wetting [how much the fluid spreads]
- Contact angle less than 90 → better wetting more than 90→ poor wetting

IMP: for good adhesion to occur you need –

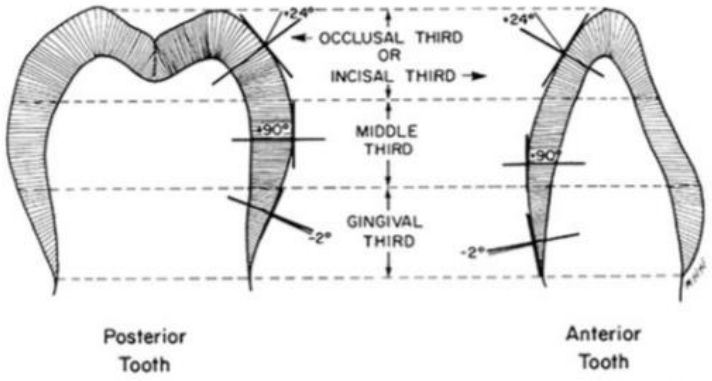
- Close contact between adhesive and substrate
- Surface tension must be **lower** than surface energy

Cohesive failure – failure within the same material

Enamel adhesion

Enamel rods :

- In pits and fissures they converge over each other
- In marginal ridges and cusp tips they diverge away from each in the cusp inclination then they intermingle in the cusp tip and marginal ridges [gnarled enamel]
- Cervically – they are directed apically



Enamel bonding	Dentin bonding
Etching + bonding	Etching + priming + bonding

Fluoride → decreases surface energy and prevent wetting by adhesives

Importance of etching: remove surface contaminants and superficial fluoride layer and dissolve the ends of the E.rods creating micro pits and pores → increase surface energy

If after etching the tooth becomes contaminated with saliva or water → etch again

Etching should produce the chalky white appearance of the enamel.

- Type 1 etching: dissolution of prism core and not periphery
- Type 2 etching : dissolution of prism periphery and not core
- Type 3 etching: some areas resemble type 1 and type 2 , other areas don't have distinct topography

Etching is usually with 37% phosphoric acid for 15 seconds [if you use a higher concentration → poor quality etching]

If you etch for 60 seconds = same effect as etching for 15 seconds

Dynamic etching application = rubbing the etchant against the enamel surface with a microbrush → more effective demineralization specially in cases of unprepared enamel to remove the fluoride rich layer

- Increase etching time in case of fluorosis
- Decrease etching time in case of hypocalcification

Mechanical etching = micro abrasion with aluminium oxide particles under air pressure

Dentine adhesion

- Peritubular dentine surrounding the dentinal tubules is more mineralized than intertubular dentine
- The # and diameter of dentinal tubules increase as you get closer to the pulp

You need to prime before you use bonding agents on dentine

Bonding to dentine is much harder than enamel because :

1- it contains more proteins and water
2- outward pressure of the dentinal fluid prevents the resin infiltration into the tubules
3- smear layer decreases wettability of the adhesive – even if good wettability occurs , polymerization shrinkage can pull the smear layer away from dentine and produce micro gaps.

Smear layer = dentin chips + saliva + bacteria – adheres very well to the dentine and inside the dentine tubules forming smear plugs

If you remove the entire smear layer it will increase the dentine permeability leading to post op sensitivity , the best is to remove the smear layer for better adhesion but **leave the smear plugs**

If you do total etching of dentine → smear layer and smear plugs are removed →collagen fibers exposed →removes peritubular dentine at the orifice of the dentinal tubules →funneling effect

Etching agents	Primers	Bonding agents
• Weak organic acids – polyacrylic acid • Strong inorganic acids – phosphoric acid • Chelating agents – EDTA	hydrophilic bifunctional monomers to facilitate the wetting and bond of adhesives ex: HEMA, 4 META, BPDM contains solvents such as water , ethanol- water, acetone	Hydrophobic Ex: BIS – GMA or UDMA or TEGDMA

If hydrophilic resin is applied on demineralized dentine → resin will infiltrate the collagen fibers creating a **hybrid layer** + opens the dentinal tubules and creates resin tags.

If the resin infiltration is not equal to the demineralization of dentine → gaps are created that are later filled with dentinal tubule fluids. This will destroy the hybrid layer that will forms → leakage and de bonding leading to sensitivity

Tubule wall hybridization : the ultimate condition – resin infiltrates the demineralized part of the dentinal tubule creating a hybrid layer on the DT walls

Adhesive systems

Total etch

= etch and rinse [etching step is separate]

Ex: etch → rinse→ apply primer [DON NOT CURE] just dry → apply bond and cure

Advantage: high bond strength **disadvantage : post op sensitivity**

The more hydrophobic components in the system → the stronger the bond. In 3 step total etch the hydrophilic primer is covered by the hydrophobic bonding agent that's why it is the strongest bond

Q: what is the problem with total etch systems? Post op hypersensitivity because:

1- More irritating to the pulp because it exposes the dentinal tubules
2- Since etching is done in a separate step the amount of resin infiltration does not completely equal the amount of demineralization → micro gaps + fluid from DT → destroy the hybrid layer

Self etching adhesives: you are etching and doing resin infiltration at the same time but this will remove the minerals and smear layer and incorporate them into the hybrid layer resulting in a weaker bond.

Advantage : less post op sensitivity **disadvantage: weaker bond**

Self etch adhesives can be:

- **Mild strength =** etch dentine only without removing smear plugs – you need to etch enamel separately – forms shallow hybrid layer
- **Moderate strength**= do not remove smear plugs completely – medium size hybrid layer – you need to etch enamel separately
- **Strong =** can be used on enamel and dentine

Self etch adhesives are used when you only have dentine and no enamel → less post op sensitivity

Q: what is the problem with self etch adhesives? Weaker bond strength because eof the incorporation of the smear layer and minerals from etching into the hybrid layer.

Adhesive generations

4th	**Total etch [3 step etch and rinse] GOLD STANDARD**	**Etch → rinse → apply primer [dry] → apply bonding and cure**
5th	**Self priming adhesive [2 step etch and rinse]**	**Etch → rinse → apply adhesive [adhesive and primer are together] ** what we use in clinics**
6th	**Self etching primer [2 step self etch]**	**Apply primer [primer and etchant together] → apply bonding agent DON'T RINSE**
7th	**One step self etch**	**Etchant + primer + bonding are together**

self etch in 2 bottles → store at room temp one step → store at 4°

Q: what is the importance of subjecting the bonding to air? To ensure it's flow to all cavity walls

NOTE: in total etch systems you need to have cavity not too wet and not too dry [just a little bit moist]

- Cavity too wet → the water will prevent the resin in the primer to infiltrate → no hybrid layer formation
- Over drying the cavity → collagen fibers will collapse and stick together → no space to be infiltrated by the primer

Q: what are solvents in dental adhesives? Mention them and briefly explain.

Added to adhesives to make them more homogeneous, decrease it's viscosity and increase their wettability + re expand collapsed collagen fibers in the dentine

- **Water :**
  Can reexpand collapsed collagen but has low vapor pressure → excess is not easily removed never added alone – ethanol or acetone must be added to increase vapour pressure and allow excess water to be removed
  if you add HEMA [hydrophilic] with water → gel forms that will not cure and weaken the bond
- **Ethanol :**
  High vapour pressure – excess evaporates
  Inactivates acidic monomers and decreases the etching by [esterification reaction]

- **Acetone:**
  Highest vapour pressure – excess is easily removed (water chasing effect -very good water removing capacity)
  Since it evaporates very quickly → poor shelf life [that's why it comes in small doses]
  Cannot expand collapsed collagen

**acetone causes phase separation between hydrophilic and hydrophobic layers → water droplets in adhesive interface → poor bond

Q: what is ethanol- wet bonding ? completely soaking the cavity with ethanol to drive all the excess water out and re expand the collagen – there are not products for this concept.
Q: **what is selective etching technique?** You etch enamel alone the dentine

Universal adhesives **: can be –**

- Etch and rinse
- Self etch
- Or both

NOTE: to ensure better enamel bond strength of universal adhesives → etch the enamel with phosphoric acid before applying universal adhesive . [no need to pre etch dentine]

You can also increase bond strength by applying multiple coats of bonding agent [4 coatings]

** multiple coatings decrease nano-leakage

YOU CAN'T USE SELF ETCH ADHESIVES WITH CHEMICAL / DUAL CURED COMPOSITES – **the uncured acidic monomers in the oxygen inhibition layer of the adhesive will react with the tertiary amine in the chemical cured composite→ incomplete polymerization of the chemical / dual cured composites**

- You can use 2 step self etch with chemical cured composite [because the primer will be separated from the composite by the hydrophobic bonding agent]
- Use chemical co- activator if you are bonding one step self etch to chemically / dual cured composites

Q: mention some advanced in adhesives?

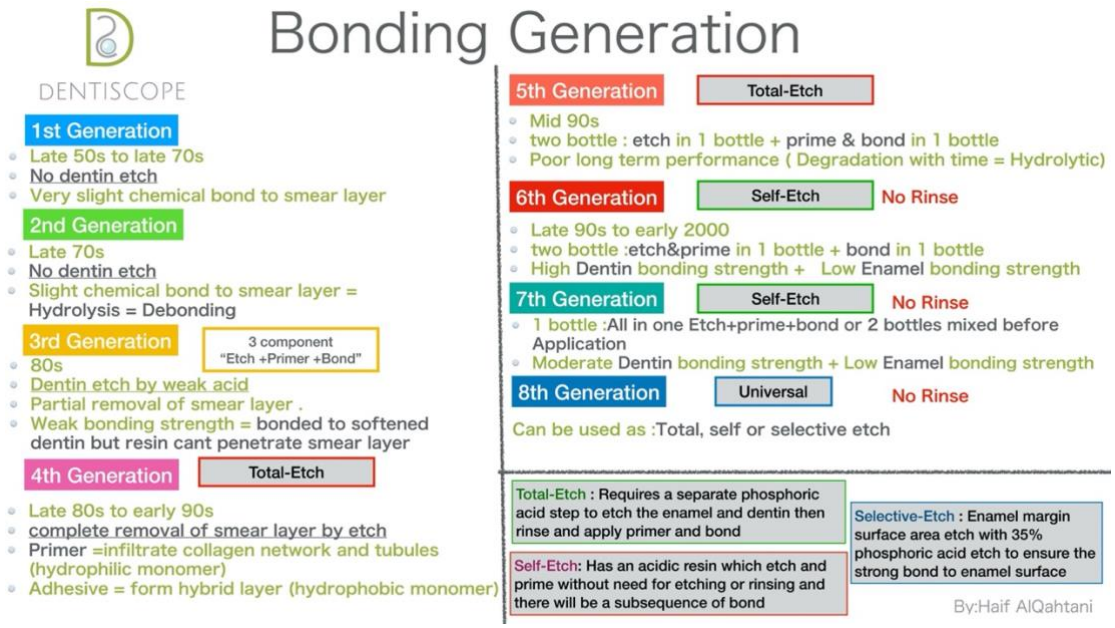
- **Fluoride releasing adhesives**: imperva FL bond , reactmer bond [GIC based adhesives]
- **Antimicrobial activity** : MDPB , GLUMA

> 10 – MDP → is **a monomer** that chemically bonds to the HA of enamel and dentine [used in self etch adhesives and self adhesive resin cements]
> Self adhesive resin cements contain either 10 – MDP or 4-META which are **adhesive phosphate monomers** that allow it to bond to the tooth structure
> Eugenol → interferes with the polymerization of resin based materials
> CHX → applied in the cavity to prevent MMP from degrading collagen and the hybrid layer – CHX applied after rinsing the etchant you just apply it then dry it then apply bonding agent

Adhesive systems summary

Adhesives Strategies

Bonding Generation



Adhesives for direct restorations and indirect restorations with light-cured cement

Adhesives for indirect restorations (Chemical or Dual curing)

Treatment planning

Treatment planning

1-Urgent phase : Treatment of symptoms (chief complaint) and non-acute problems that need immediate attention

Ex:

- Fractured anterior tooth/restoration
- Cracked tooth syndrome CTS

2-Control phase: stabilization of conditions like periodontal disease or caries by remove etiology factors and education the patient

Ex:

- Modifiy caries risk by diet counselling and reinforcing oral hygiene + application of CAMBRA protocol [CHX mouthwash / sealants / fluoride varnish if needed]
- Pt education and motivation
- Temporization for all cavitated lesions with GIC / RMGI
- Plaque control – SRP + CHX mouthwash if needed [based on perio risk]

** might included pulpal therapy [direct / indirect pulp capping or recontouring a damaged tooth surface to enhance plaque control]

3-Advanced phase / Reevaluate : reevaluate of the response to control phase - advanced procedure for definitive phase

Ex:

- gingival response to plaque control
- Pulpal response of cavitated lesions sealed with GI/ RMGI
- pt compliance with oral hygiene and diet modifications
- check for any new carious lesions or changes in previous lesions
- post and core prep for final crown treatment
- bleaching before shade selection of final restoration in definitive phase

4-Definitive phase : permanent restoration

Ex:

- Composite / Amalgam / PRR / FS restoration
- Inlay / onlay / endo crown
- Vaneers

5-Maintenance phase: Follow up and reevaluation of risk factors

Ex:

- OH reuvaltion and motivation
- Bitewing and PA
- Dental charting

Management of pits and fissures caries

Pits and fissures caries:

- occlusal surfaces of posterior teeth
- buccal and lingual pits on post teeth
- palatal pits of max incisors

** don't use a sharp explorer to detect fissure caries → it can remove the protective organic plug and induce cavitation – use a blunt probe in a horizontal movement across the surface to detect any enamel breakdown

Whatever the case you need to manage pt's risk factors first then individual carious lesions

Caries detection does not equal caries diagnosis .

Diagnosis means you mean the extent, severity, activity, location of the caries + pt's caries risk

Radiographs are not very reliable in detecting occlusal caries because of the superimposition of the buccal surface – best way to detect fissure caries is clinical examination

Hidden caries: when clinically the caries don't appear to be large with only a shadow but on radiographs they are huge.

- The only exception to using a sharp explorer is when you are checking arrested lesions.
- Arrested lesions don't need restorations unless it is to improvement esthetic
- Whatever the case of caries , you need to treat the pt as a whole considering their caries risk [fluoride exposure, oral hygiene, diet , salivary flow rate etc.]
- **The ICCMS system considers : pt history, caries classification and helps you decide how to manage caries in a customized approach and determine the recall intervals for prevention**

Even if the cavity is large but the caries are arrested → no need to remove the caries just seal the cavity with a restoration to stop it's progression.

- **Initial active lesions** → non operative care - NOC [modify risk factors, improve oral hygiene, salivary flow etc]
- **Moderate / extensive lesions** → tooth preserving operative care – TPOC

Caries control phase main objective is to seal all carious lesions → reduce plaque accumulation and improve risk before doing definitive restorations.

Treatment options for P/F caries :

1- Fissure sealants:

Indicated with deep plaque retentive fissures or incipient caries in a moderate risk pt – preventative approach

No need to place sealants in low risk pts

Can be : flowable composite – glass ionomer or RMGI

Resin based fissure sealants have the highest success in preventing caries because of their superior adhesion to enamel by mechanical interlocking.

GIC fissure sealants frequently de bond and lead to plaque accumulation and caries.

Defective sealants can cause greater caries progression underneath them

2- **Preventative resin restoration [PRR] :**
Used if there is a small carious lesion on the occlusal surface → remove caries up to the DEJ [to avoid undermining enamel] → restore with flowable or packable composite depending on size and seal the remaining fissures with fissure sealants.

3- **Enameloplasty :** slightly widening the fissure to allow better adaptation and greater thickness of the fissure sealant
Best done with flame shaped diamond bur and remove maximum 1/3 of enamel

Q: Do all carious fissures require drilling? No, non cavitated incipient fissure caries can be sealed with sealants

Minimal intervention management

1- **Ozone :**
Used to disinfect the cavity and kill bacteria before placing a final restoration
Oxidizing properties also remove biofilm
Ozone is proved to reverse root caries

2- **Air abrasion: kinetic cavity preperation**
- Used as an alternative to rotary – less irritating to the pulp
- Abrasives + compressed air → more precise tissue removal, painless and less heat generation
- Bond strength of composite on air abraded E and D is no different than bond strength using etch and bond

3- **Chemo- mechanical caries removal [carisolv]:**
- Conservative caries removal
- **Helps differentiate between sound and infected dentine**
- One bottle contains amino acids [lucine , lysin, glutamine] + another bottle has sodium hypochlorite in low concentration
- **NaoCl d**issolves decayed dentine but not sound dentine and the amino acids buffer the acidity
- **Dissolved dentine is then removed by light excavation**

4- **Guided laser ablation**
- Used with diagnodent
- By using Er:YAG laser and laser induced fluorescence feedback system
- The laser will detect fluorescence emitted by bacterial metabolites and be activated to cut , when it detects sound dentine the laser is not emitted → **no cutting**

5- **Smart prep bur:**
- Has a hardness lower than the hardness of sound dentine and but more than soft carious dentine → only removes carious dentine
- Excellent in deep caries removal to avoid pulp exposure
- Has high wear rate & expensive → if you apply pressure on the bur or touch sound dentine/ enamel it will not removes sound dentine it will only cause the bur to wear down
- expensive
- results in under preparation because it leaves large amount of decayed tissue

Management of smooth surface caries

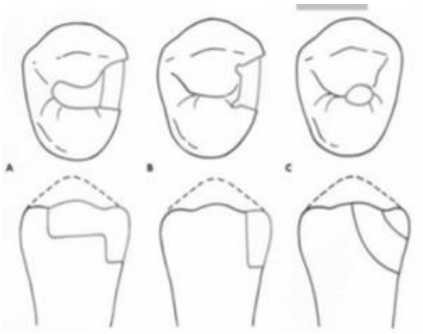
Smooth surface caries = class II,III,IV,V

- Difficult to detect
- Start as kidney shaped white spot lesions under the contact point → then Spread conically then laterally at the DEJ and coronally to undermine the marginal ridge [shows as dark shadow under the marginal ridge]
- **Likey to recur at bucco / lingual – gingival line angle**

Q: how can you detect proximal caries?

1- Ideally by bitewings
2- You can do tooth separation using ortho bands and then visualize the lesion
3- Use transillumination [FOTI and DIFOTI] – best for class III
4- Diagnodent [better for smooth and occlusal surface caries than proximal caries – better from perm than primary teeth] ** results can be affected by presence of plaque, staining, and level of hydration of the tooth

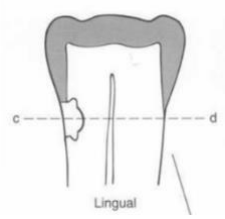
Q**: restoring proximal caries is challenging mention cases when it is simplified?**



1- Missing adjacent
2- Rotated tooth
3- Direct access through an adjacent cavity
4- Gingival recession → easy access

Posterior proximal caries prep options

A. **Conventional** – proximal + occlusal
B. **Proximal box preparation** – when occlusal surface is sound
C. **Tunnel prep –** to preserve marginal ridge
D. Buccal / lingual slot prep - in older pts with gingival recession or in case of wide embrasure **[the contact point should be intact and does not need a restoration] – amalgam is particularly indicated for slot preps if isolation is difficult – retentive grooves should be placed occlusally and cervically**



The facial and lingual walls should approach the proximal of the adjacent tooth at 90° - proximal clearance = 0.3-0.5 mm [the tip of the explorer should be able to passthrough]

** if you can 2 adjacent lesions one big and one small → prep the big one first then prep the small one through the big one then fist the small one first then the big

Restoring proximal contact: **matrix systems + wedges**

1- Toffelmire matrix [universal matrix] – larger circumference is the occlusal edge / smaller circumference is the gingival edge – should be contoured and burnished toward sthe adjacent tooth + stabilized with a wedge
2- Automatrix
3- Precontoured sectional matrix + ring clamp [best proximal contour]

Wedges applied from lingual side to stabilize the matrix – it should not impinge on the matrix or change it's contour

Packing/ reflecting tips can be used to pack composite proximally and ensure appropriate curing

Anterior proximal lesions

- most esthetic approach for class 3 → lingual approach [you preserve facial enamel + composite discoloration will not be visible – you can retain some unsupported facial enamel]
- only approach facially if caries are located facially or the tooth is rotated in a way that you can't access lingually
- For class III→ use contoured mylar strip to restore contact – if the lesion is too cervical you can place a precontoured sectional matrix to restore gingival contour
- For optimal esthetics – different composite shades can be layered

Class IV → usually caused by a large class III that undermined the incisal edge

If the cause of class IV is trauma → you can use flowable composite to re position the fractured segment back onto the tooth and then do a labial composite veneer

Restoring class IV

1- **Celluloid crown formers to restore the edge** - trim the crown former to cover all prepared margins – fill it with composite and cure
2- Free hand build up – requires skills and is time consuming
3- **Mock up and silicone index** – in case a previous class 4 restoration needs replacement → take a PVS impression and form the silicone index or do wax up on the cast → silicone index

Management of cervical caries

Cervical lesions can be :

- **Carious**
- **Non – carious [abfraction, abrasion, erosion]**
- **Combination of both**

A. **Abrasive erosive lesion : tooth brushing abrasion with acid erosion from soft drinks**
B. **Carious + non carious lesion : caries over abfraction or abrasion**

Cervical caries are GV black class 5 - They occur on the gingival 3rd of buccal / labial or lingual of all teeth except for lingual of max laterals.

- Regardless of the cause all cervical lesions are treated the same way.
- IMP: enamel and dentin are thin cervically and DT are short and straight → cervical cavity preps can easily end up with pulp exposure or dentinal hypersensitivity

Smooth surface [proximal / cervical] surface lesions tx options based on extent:

1- **Incipient inactive lesions** → remineralization
2- **Incipient active lesion** → tx by remineralization/ resin infiltration and only do a restoration if esthetically un acceptable.
Remineralization of incipient lesion can be :

A. In office [fluoride varnish application + calcium based products]
B. At home [fluoride tooth paste / 1.23 % sodium fluoride gel]

Resin infiltration: for incipient non cavitated lesions [ICON infiltration]
For proximal lesions - Indicated only if the lesion extends maximum to the outer 3rd of the dentine and is not cavitated
Lesion beyond the outer 3rd of dentine → do a cavity [if you detect incipient proximal lesion on the adjacent while doing the cavity you can use infiltration on that lesion]

1- Etch with 15 % HCL [hydrochloric acid] for 2 mins
2- Rinse acid for at least 30 seconds + air dry
3- 30 seconds application of ethanol to check enamel opacity
4- Apply resin infiltration + light cure for 40 seconds then remove excess with floss interproximal

3- **Enamel cavitated lesion →**
class 3 is best seen by transillumination → minimally invasive restoration [composite micromechanical retention]
Cervical → minimally invasive restoration [micromechanical retention]

4- **Dentinal caries with all margins on enamel** → remove all carious dentin + bevel facial enamel margins

- If deep → GIC liner
- If extensive → retention grooves [in class V retention grooves are placed cervically and occlusally]

5- **Dentinal caries with margins extending to root surface** → open sandwich technique + retention grooves placed with a ¼ round bur, 0.5 -1 mm away from external root surface [inside the CEJ] – beveling the facial enamel is mandatory

Cervical lesions material options

Treatment	Advantage	Disadvantage
Direct gold	• Best biocompatibility • Excellent seal and surface finish	• Unnecessary removal of tooth structure for retention • Unaesthetic , expensive • Difficult technique – time consuming ** gold requires heavy condensation forces
Amalgam	Can be used if isolation is a problem Can be use din high risk pts where composite is contraindicated and the pt is not following instructions to lower their risk	• Unnecessary removal of tooth structure for retention • Unaesthetic
Glass ionomer	• Fluoride release • Bonds chemically to tooth • No necessary cavity prep • Not moisture sensitive	• Opaque [not esthetic] • High wear
RMGI	• Fluoride release • Better esthetics and wear resistance than GI • Better bonding than composite ** when RMGI dissolve sit dissolves from the surface and not the margins → less chance of recurrent caries	• Esthetics inferior to composite
Resin composite	• Highest esthetics • Excellent bond to enamel	• Doesn't bond well to dentine ** consider lesion depth • Technique sensitive require optimal moisture control • Marginal discoloration and secondary caries

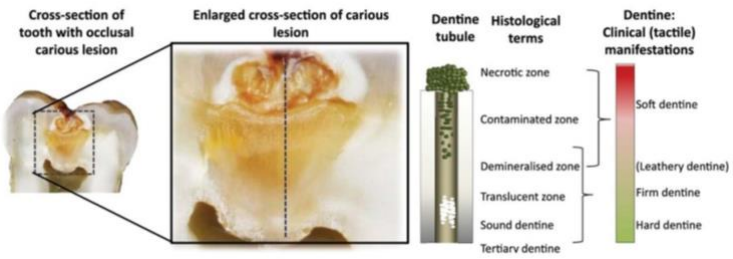
Q: what can you do to gain access to a subgingival class 5 ?

1- Releasing incision
2- Surgical flap
3- Use a 212 retainer with rubber dam

Then do proximal box elevation with GI

Management of deep caries

- **Infected dentine =** has bacteria + irreversibly denatured collagen → **must be removed**
- **Affected dentine =** no bacteria + collagen is reversibly denatured → **you can keep**



Clinical appearance	
Infected dentine	Affected dentine
Soft , yellowish brown in color Easily removed	Leathery , darker brown in color Harder to remove

- In deep caries the pulp responds to defend it self by forming <u>tertiary dentine</u>

<u>Deep carious lesion = caries penetrated ¾ of the dentine thickness or more when evaluated on radiograph.</u>

- **Actual cavity depth = distance from CSM to pulpal floor – should be compatible with material properties [amalgam needs 1.5 -2 mm]**

** children have large pulps with high pulp horns → higher chance of pulpal exposure even in shallow cavities

- **Clinical cavity depth =** thickness of dentine bridge over the pulp **– important for thermal irritation to the pulp** [dentine bridge is measured by radiograph]

If clinical cavity depth : IMP

>2mm → expect healthy reparative dentine
0.8-2mm → unhealthy reparative dentine
0.3-0.8 mm → pulpal involvement

- **Effective cavity depth =** thickness of the dentine bridge following the wavy course of dentinal tubules from pulpal floor to the roof – **important for chemical / bacterial irritation to the pulp**

** the wavier the dentinal tubules the more the distance between the caries and the pulp – that's why in cervical and proximal caries the DT are straighter → shorter distance to the pulp
<u>Effective cavity depth is the most representative depth for pulpal irritation</u>

<u>In deep caries → ask about pain history + pulp test [cold test + electrical pulp test]</u> – you cannot depend entirely on radiographs because:

1- Radiographs are 2D of a 3D object → don't really show buccal and lingual lesions
2- Little quality in showing occlusal caries [buccal surface overlap]
3- Cannot detect small pulp exposures
   - ➢ Radiographs are great for proximal lesions and showing the remaining dentine thickness [RDT]

pulpal exposure is more common in acute lesions because dentine is softer .

caries removal end point is still the hard feeling of sound dentine [very subjective and depends on clinical skills]

Q: what can you use to aid in caries detection and removal ?

1- **Caries detector dyes [0.5% basic fuchsin or 1% acid – red in propylene glycol base]**

- **stain the organic matrix of less mineralized dentine** [not very accurate – because they don't stain bacteria so they don't show where infected dentine finishes and affected dentine starts]
- result in over preparation of the cavity because they stain infected dentine and demineralized matrix of carious dentine [which should not be removed]

2- **Soprolife**

- Removal of caries guided by light induced fluorescence [sound dentine reflects different wavelengths compared to carious dentine this is detected by a camera

Caries control phase using GI or RMGI indicated when:

1- Pt's caries risk is high and you need to modify risk factors and oral environment before doing definitive restorations by removing the nidus of bacteria and sealing all cavities with a fluoride releasing material – this will also cut the nutrient supply for the bacteria present arresting the caries.
** caries control is most effective when all carious lesions can be treated in a single appointment

2- Caries are deep and extensive and you expect adverse pulp reactions or pulp exposure [direct/ indirect pulp capping]

Deep caries management	
Pulp exposure	No pulp exposure
• **Direct pulp capping –** indicated in mechanical pulp exposure of sound dentine during cavity prep [no bacterial contamination] • **RCT –** indicated in there is carious pulpal exposure [infected dentine extending to the pulp]	• Indirect pulp capping • Step wise excavation • Partial caries removal

Pulp capping agents

The high PH of some pulp capping agents [CaOH and MTA] causes superficial layer of coagulative necrosis that later attract crystals and fibronectin → cellular differentiation → dentine bridge formation

1- Calcium hydroxide [gold standard]

- High PH = 10-12 → stimulates dentine bridge formation + neutralize the acidity of certain cements [zinc phosphate]
- Antimicrobial
- Can act as mechanical barrier against the metallic ions of amalgam preventin gthier leak into DT
- Dissolves very easily leaving a Gap

2- **Ledermix -** Calcium hydroxide + corticosteroids [triam cenelone acetate] + antibiotics [tetracycline] - [does not cause dentine bridge formation]
3- **ZOE**
4- **MTA**
   - High PH =12.5 & biocompatible
   - Hydrophilic [can be used in areas with poor moisture control]
   - High compressive strength
   - Good sealing ability
   - Antimicrobial
   - Can stimulate growth of cementum + bone

Drawbacks:
- Very expensive
- Long setting time [4 hours]

5- **Biodentine [MTA + GI] → bioactive material**

Direct pulp capping	**Indirect pulp capping**
Application of a medication / dressing to an exposed pulp to preserve it's vitality and induce reparative dentine formation [dentine bridge] **Indications** 1- Asymptomatic tooth and vital pulp 2- Accidental pulp exposure [iatrogenic exposure] 3- Exposure size not more than 0.5 mm [pinpoint exposure] 4- Hemorrhage can be easily controlled by applying CHX cotton pellet 5- Exposure occurred in a clean un contaminated way [under rubber dam isolation] 6- No evidence of blood aspiration into the dentine [no dentine blushing] **Contraindication** 1- Irreversible pulpitis and history of pain 2- Hemorrhage cannot be controlled indicated hyperemic pulp 3- Periapical radiolucency to tooth is tender to percussion **Common error** = over drying the cavity with air to check if the bleeding stopped → this interferes with healing [that's why use cotton pellets] **technique:** 1- If pulp exposure occurs -→ control hemorrhage by applying cotton pellet with saline [if bleeding continues you can use epinephrine or 2.5 % sodium hypochlorite for 20 sec then wash and dry] 2- Disinfect cavity with CHX then dry with cotton pellet 3- Apply calcium hydroxide only over the exposure and cover it with GI ** don't place composite over calcium hydroxide because when the composite undergoes polymerization shrinkage it will pull the calcium hydroxide away leaving a gap → hypersensitivity .	No pulp exposure but you can see shadowing of the pulp and you want to protect it and induce reparative dentine formation **Technique:** 1- Excavation stopped at form hard dentine 2- Apply calcium hydroxide 3- Cover it with GI/ RMGI It is hard knowing when to stop excavating

Q: how can you tell that your pulp capping was successful ?

1- Asymptomatic tooth + vital pulp
2- No PA radiolucency or TTP

After pulp capping a final restoration can be placed after 6-8 weeks

3- Radiographically you can see the reparative dentine

Stepwise excavation [SWE]

Remove caries in 2 separate appointments that are 6-12 weeks apart to reduce the chance of accidental pulp exposure .

First appointment	Second appointment
• **Remove caries from the periphery towards the pulp** • **Leave soft , wet dentine that is close to the pulp** • **Line the cavity with calcium hydroxide** • **cover with GI for 6-12 weeks**	**Dentine becomes drier and darker in color with less microorganisms and easier to remove**

> In stepwise excavation you might end up with micro pulp exposure that you can't detect easily which can lead to failure and need for RCT

> some studies showed that not entering the cavity again did not report any adverse consequences **because the bacteria are already sealed from their nutrient source**

Drawbacks of step wise excavation :

1- requires 2 sessions → additional cost and time for the pt

2- higher risk of exposure **<u>in the second appointment</u>**

Since evidence showed that not entering the cavity again did not have any adverse effects and there is higher chance of pulp exposure in the second appointment → partial caries removal is suggested

Partial caries removal [PCR]

- Remove caries from the periphery towards the pulp
- Leave soft , wet dentine that is close to the pulp
- Line the cavity with calcium hydroxide and cover with GI
- You monitor the pt and do not re enter the cavity

Best approach : partial caries removal → seal with CaOH and GI → monitor the pt → if asymptomatic → partially remove GI and fill the cavity with composite .

Management of badly broken-down teeth

Before considering cusp capping you need to take the cusp length and width into consideration [tall , thin cuspal walls → need cusp capping]

- Weakened walls that don't receive cusp capping → fracture of the entire wall

Management of badly broken down tooth

Direct restorations	**Indirect restorations**
• **Pin/slot retained or bonded amalgam** • **GI/RMGI** • **Composite**	• **Gold / base metal** • **Composite** • **Ceramic [inlay/ onlay]**

Amalgam for badly broken down tooth	
Adv	Disadvantage
1) High compressive strength ** 2) Good resistance and retention 3) Good adaptability 4) Cheap ** 5) Can be done in one appointment **	1) Low tensile strength 2) Not easy to restore contact and proper tooth contour ** 3) Not esthetic ** 4) Flow and creep
Indications	**Contra- indications**
• Badly broken down teeth • If multiple cusps need capping • When you need more resistance / retention forms	• Pts with occlusal problems • Esthetic areas • You cannot restore proper contact and contour using a direct restoration

Auxiliary retention forms to retain complex amalgam restorations:

1- **Slots**
2- **Amalgapins**
3- **Pins**
4- **Coves**
5- **Locks**
6- **Amalgam bonding**

NOTE: in case of deep cavities → liners / bases should be 1 mm away from any slot / pin

Q: when should you do cusp capping?

** it depends on the location of the cavity margin in relation to the cusp tip and central fissure

More than ½ the distance between central fissure and cusp tip →	No need for cusp capping
½ -2/3 the distance between the central fissure and the cusp tip →	Consider cusp capping
Less than 2/3 the distance between the central fissure and cusp tip →	Cusp capping is indicated

Cusp capping technique

1. Depth guiding grooves are made : 1.5 mm in non functional cusps and 2mm in functional cusps.
2. Anatomical cusp reduction [not a flat area → you follow the contour of the cusp] – EXTENSION SHOULD PASS THE LINGUAL OR BUCCAL GROOVE
3. Round all internal angles

1- Slot technique:

- The length depends on the extent of cavity preparation – but should be minimum 1 mm long
- Can be continuous or segmented depending of tooth prep extension.
- Groove prepared 0.6 mm into dentine [if you prepare it in enamel → you will cause undermined enamel that can easily fracture]
- Prepared by an inverted cone bur to create a convergence form [opening of the slot = 0.5 mm and base = 0.6 mm]

Length = 1mm depth = 0.6 mm upper width = 0.5 lower width = 0.6 mm

2- Amalgapins:

- Small holes made in the dentine and then condensed with amalgam
- Should be placed 1 – 1.5 mm away from the DEJ – perpendicular to the pulp floor
- The margins of the pin entrance should be beveled → to increase bulk of amalgam and decrease stress concentration

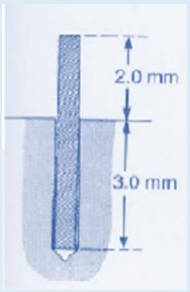
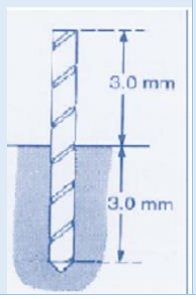
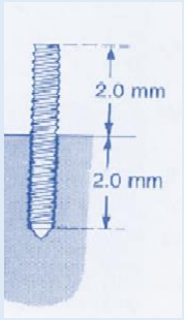
Failure of non pin retained amalgam :

1- Poor case selection
2- Not enough dentine
3- Incorrect location / direction / depth
4- In adequate amalgam condensation

3- Pins : used when you can't get enough retention / resistance from slots , locks etc

Advantage	Disadvantage
Cheap	Microleakage around the pin
Quick	Dentinal microfracture or crazing around the pin
Conserve tooth structure	Perforation [towards pulp / external wall]

Types of pins:

Cemented	Friction locked pins	Self threating pins [thread mate system]
• **The hole is slightly larger than the pin width** • **Pin has smooth surface** • **Cemented with ZPC / ZP cement** 	• The hole is slightly smaller than the pin width • Smooth with continuous spiral groove • Depends on friction grip with the dentine • Better retention than cemented type but with time the dentine relaxes → loose pins 	• Hole is slightly smaller than the pin • Screwed into the dentine using threads • **MOST RETENTIVE** • **Gold plated provide no corrosion** • Create horizontal and vertical stresses → dentine craze lines • Size selected based on amount of remaining dentine + amount of retention needed • Inserted manually or using low speed hand piece **Self limiting** : only the cutting part goes into dentine – a shoulder prevents further advancement and pulp exposure 

Rule of 2 in pin placement:

- Pin should be 2 mm into dentine
- Pins length above pulpal floor = 2mm
- Pins should be covered by 2 mm of amalgam

** retention is not increased if more than 2mm of the pin engages the dentine → this will fracture the dentine

Pin placement :

> **Avoid :** pulp , bi frucations, trifurcations, root concavities **[pins should not be placed on the mesial surface of max 1st PM – because the mesial concavity can cause the pin to perforate externally]**
> **Number of pins** : depends on the remaining tooth structure and how large the restoration is and amount of retention you need.
> **Technique:** Prepare a flat seat in dentine → with ¼ round bur create pilot hole →drill should be parallel to the external walls [drill in one shot – drill should be rotating when you insert it and when you take it out]

- Pins should be located on different vertical levels
- Interpin distance depends on the width of the pin [ranges from 3-5 mm]
- Pins should be parallel to external walls but not parallel to each other - if you find that the pins are parallel to each other → use a tool to bend them
- 1 mm clearance around pins for amalgam condensation / 1mm between pin and matrix band
- Use double matrix technique to condense amalgam + use longer setting amalgam

> **Mistakes:**

- Changing the direction of the drill inside the hole → hole is too large → loose pin
- If you stop rotating the drill → fracture of the pin
- Pins are all on the same horizontal plane → high stress
- Drilling not parallel to the external walls → external or pulpal perforation [because the cervical portion of the tooth is narrower]
- Decreasing the inter pin distance → high stress
- If more than 2mm above pulpal floor → amalgam fractures
- If less than 2 mm of amalgam covers the pin → amalgam fractures
- No proper condensation around the pin → separation b/w pin and amalgam
- Separation bw dentine and pin → big hole

** **most fractures occur at the pin dentine interface**

Q: what to do if the drill broke? Leave that part → move 1.5 – 2mm away from the broken pin → and drill another hole

Q: what to do if the pin was too loose? Use a larger pin or condense amalgam in that hole → move 1.5 mm away and drill another hole

Q: what to do if there was pulp exposure? Pinpoint → direct pulp capping + prepare another hole [if the pt complains of pain after the tx → RCT]

Q: what to do if there was perforation to the external surface?

Occlusal to gingival attachment	**Apical to gingival attachment**
• Cut the pin and flush it with the tooth surface • Cut the pin + place a cast restoration that extends gingivally • Remove the pin → enlarge the hole and restore with amalgam	• Reflect a flap → surgically remove bone and enlarge the pin hole + restore with amalgam • Crown lengthening + cast restoration over the perforation • Extraction

4- **Resin bonded amalgam**

Chemically cured Resin cement [4 – META] is placed directly over the cavity → pack amalgam directly over uncured resin cement → glass fillers and the amalgam intermingle and harden together →better bond strength + reduce microleakage and sensitivity

Resin bond breakdown will be compensated by the corrosive products of amalgam → seal is maintained

Indications:

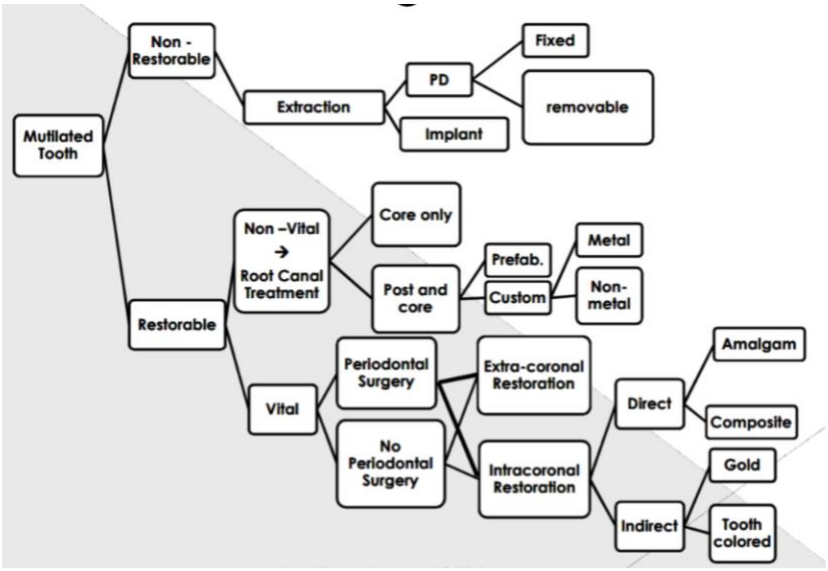
- large restorations / badly broken down tooth to provide better retention
- when you need improved initial seal [like after pulp capping]

Adv:

1- Minimize initial microleakage / marginal ditching
2- Better retention / resistance
3- More conservative
4- Reduce sensitivity

Technique:

1- Rubber dam
2- Etch – prime – bond [chemical cured resin cement]
3- Apply matrix
4- Pack amalgam directly over the wet resin cement
5- Use scalpel or sharp chisel to remove and excess resin proximally



Cast metal indirect restorations

- Indirect restorations = restorations made outside the pt's mouth
- Onlay = indirect restoration that covers one or more cusps and proximal areas
- Inlay = indirect restoration that does not cover any of the cusps

Indications of cast indirect restorations	Contraindications of cast indirect restorations
1- Large restorations [when you need higher strength or superior control over contour and contact] **2- Alternative to a crown [when the facial and lingual walls are intact]** **3- Extensive proximal caries [it allows you to have excellent control of contact and contour]** **4- Teeth at risk of fracture because of undermined cusps** **5- To modify occlusal anatomy** **6- The opposing or the adjacent is a metallic restoration** **7- shallow isthmus [indirect restorations will prevent isthmus fracture]** **8- Tooth will be an abutment for RPD**	1- Esthetic is a concern → use non metallic restoration 2- High caries risk → use full coverage ** inlay and onlay will still have many margins exposed to the oral cavity → risk of recurrent caries 3- Small cavities → use direct restorations

Indirect restorations materials

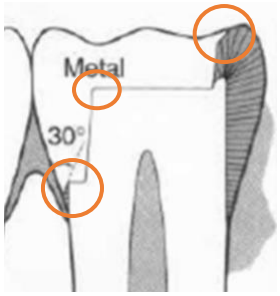
Metal	Non metal [esthetic]
Gold **Palladium – silver** **Base metal**	Indirect composite ceramics

Indirect Gold	
Advantages	**Disadvantages**
1- Biocompatible **2- Strong** **3- High wear and creep resistance** **4- Excellent control of contacts and contours**	1- Time consuming [several appointments] 2- Expensive 3- Technique sensitive 4- Increased margin's length [compared to full coverage crowns] 5- Need temporary restoration

direct gold is no longer used – they used to heat gold made from thin sheets and make it into a ball then condense it into the cavity - required high condensation forces

Inlay preparation

1- **Occlusal divergence should be 6°** [done by tapered fissure bur] if you are using cylindrical burs → tilt to achieve 6° divergence
** ideal bur for inlay → thick tapered fissure bur with round end
2- Occlusal reduction = 1-1.5 mm / isthmus should be 2 mm wide
3- Cavity should not have any undercuts
** undercuts will affect the path of insertion and withdrawl of the restoration - can be fixed in 2 ways:
   A. Blocking the undercut with GI/ flowable composite
   B. Blocking the under cut with wax by the technician → can lead to a gap bw restoration and the tooth
   C. Removing the undercut → can lead to excessive tooth structure removal
4- Proximal box :
Gingival seat should be 0.5 mm away from the gingiva and 1 mm away from the adjacent tooth
Proximal box should be wider buccolingually



5- **Gingival margin should be as even as possible – without irregularities**
** irregularities make it hard for the technician to trace the cavity → deficient or over extended material
6- 30° Bevel on the gingival margin and axio pulpal line angle
7- **Bevel the CSM** → increases adaptation and reduces cement exposed to the oral cavity
8- **Ensure round internal angles and parallel walls**
9- **Buccal and lingual contact clearance of 0.5 – 1mm**
10- **Retentive grooves placed on axio - facial and axio - lingual line angles**
If you are close to the pulp → CaOH and GI

Onlay preparation

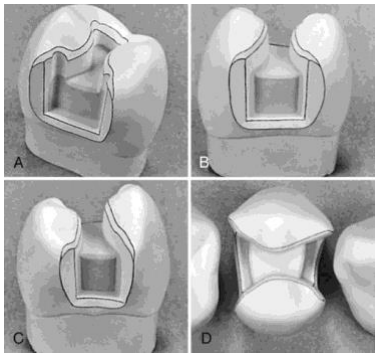
- Same as inlay + anatomical cuspal reduction [2mm for functional and 1.5 for supporting cusps]
- In gold onlays → **counter beveling on facial and lingual cusps** is needed to [longer bevel on the working cusp] – to prevent fracture by making gold cover the external surface

**** A counter bevel is not placed on buccal cusps of maxillary premolars and first molar for esthetics**

To improve retention of gold onlays:

1- Decrease the taper by 2 °
2- Collar prep [heavy reduction from the external surface + small bevel]
3- Skirt prep [extending the bevel more]

4- Slot prep



Inlay bevels
Divergence of 5-6 °
Axio- pulpal line angle
Gingival bevel = 30°
CSM bevel
**** onlays → all + counter bevel that is longer on the working cusp**

Impression for cast inlay / onlay

1- Retraction cord
2- Stock tray → heavy body + light body around the prep
3- Pour the casts + mount according to interocclusal records
4- Wax pattern + investing → lost wax technique [wax elimination] → casting → de investment
5- Finishing and polishing → try in inside pt's mouth → cementation

Esthetic indirect restorations

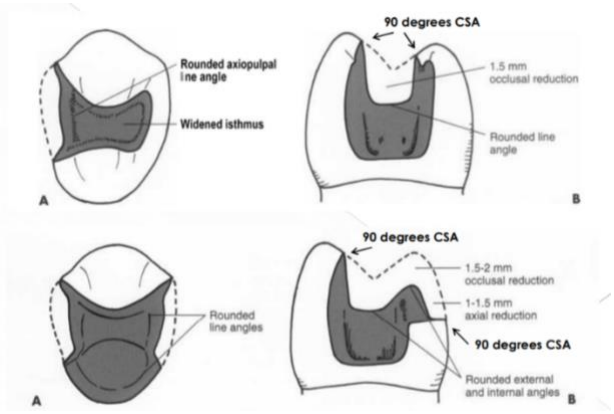
Indirect resin restorations advantages:

1- Better physical properties [higher strength + better wear resistance+ better color stability]
2- Better control over contour and proximal contacts
3- No polymerization shrinkage [less microleakage + less post op hypersensitivity] because polymerization has already occurred outside the mouth
4- Composite is free of voids and is denser
5- Excellent esthetics
**ceramic onlays have less material wear compared to resin composite but they cause more opposing tooth wear.

Esthetic indirect restorations	
Indications	1- Large cavities 2- Esthetics is a concern 3- Cuspal coverage is needed 4- Heavy occlusal forces 5- Inability to obtain a dry field – you can't place direct composite ** 6- Deep subgingival prep

Resin inlay / onlay prep is similar to gold onlays except:

1- Butt joint CSM
2- No need for additional retentive features
3- You can block the undercuts with RMGI or flowable composite
4- Palatal / lingual cusp reduction = 2-3 mm
5- **Buccal cusp reduction = 1.5 -3 mm**



DIE = the poured master impression – the cast that has the prepared tooth

Resin inlays /onlays

Direct	1- Cavity preparation 2- Place water soluble separating medium + matrix 3- Fill the preparation with composite increments + cure from all directions then remove matrix 4- Remove the inlay/ onlay and cure it again 5- Try in and adjust margins → Etching & BONDING→ finishing and polishing ** one appointment + no need for temporary restoration
Direct/ indirect	1- Cavity preparation → PVS impression 2- Pour the master impression to make master die [from silicone material or fast setting stone] 3- Fabricate the restoration on the die + light cure 4- Try in → etch and bond

	** same appointment [but takes long time] + no need for temporary restoration + better control of contact and contour because it is being prepared outside the mouth https://www.youtube.com/watch?v=sDmPL58k-aA
Indirect	1- Cavity preparation → PVS impression 2- Take impression of opposing arch + bite registration 3- Restoration is fabricated in the lab ** best contour and contacts but technique sensitive + needs temporary restoration + expensive

Indirect ceramic inlay/ onlay cementation

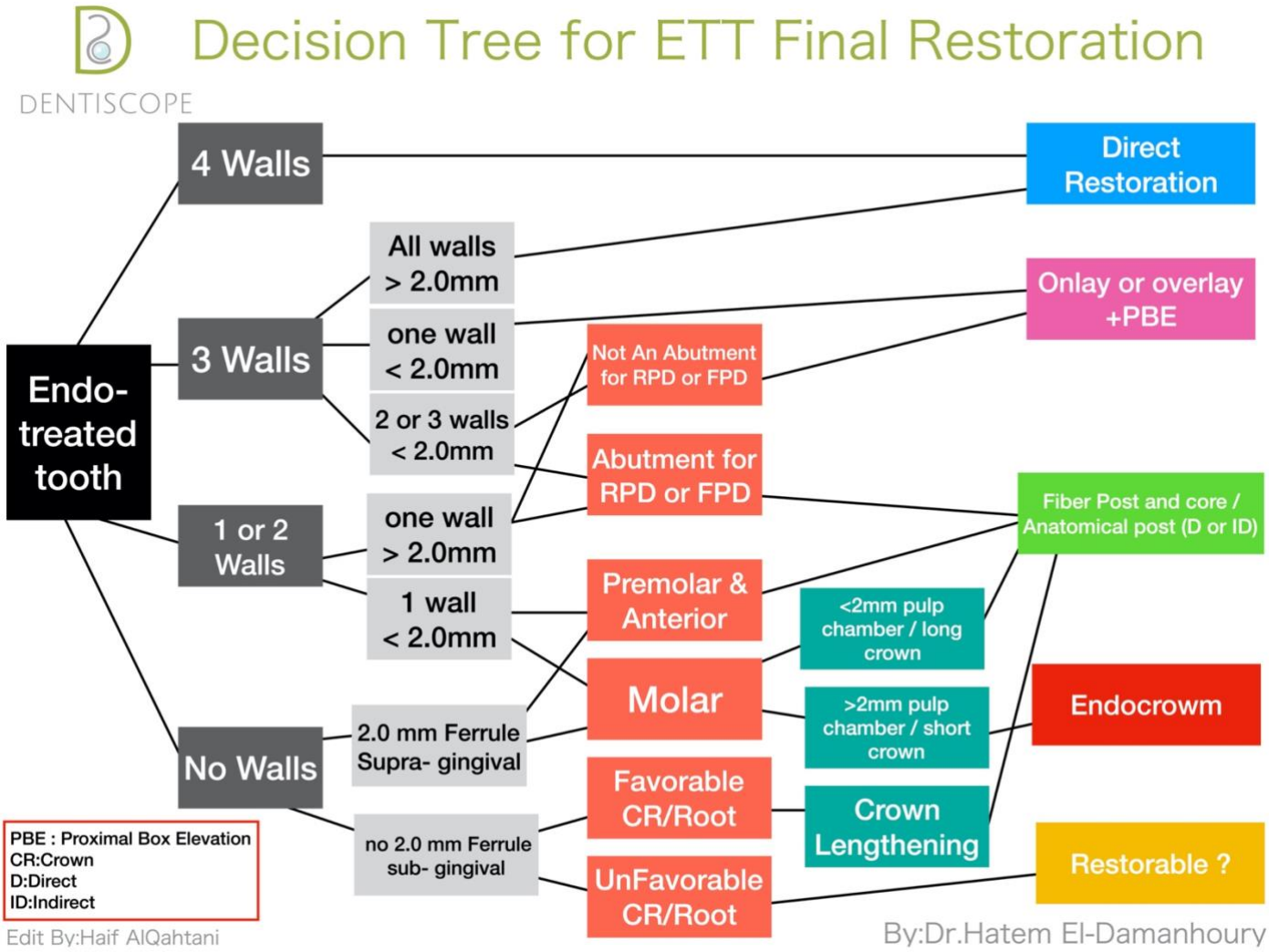
1- **Onlay / inlay : Etch the porcelain with hydrofluoric acid → rinse over neutralizing agent in a plastic cusp → apply silane coupling agent [primer]**
2- **Etch tooth surface with phosphoric acid then apply monobond**
3- **Cement using resin cement**

Inlay / onlay materials :

1- Resin composite
2- Feldspathic porcelain - [low fracture resistance]
3- Pressable ceramics [ex: IPS empress] – hardness / occlusal wear / coefficient of thermal expansion = same as enamel
4- Milled ceramics

CAD – CAM = computer aided design – computer assisted manufacturing → a digital impression of the cavity is taken then design is fabricated on a computer system → restoration made from ceramics using milling process

Decision tree for endo treated teeth final restoration



Temporary / Provisional restorations

- **Temporary restorations = restorations placed maximum for 10 days - ex: ZOE**
- **Provisional restorations placed for longer periods [6- 10 weeks] – ex: reinforced ZOE / acrylic resin**

Q: why do we need to place temporary restorations?

1- Protect the pulp in between visits
2- Maintain occlusion
3- Maintain function and esthetics
4- Monitor the tooth for symptoms specially after direct/ indirect pulp capping
5- Anti – cariogenic effect in the control phase

Ideal requirements of a temporary material:

1- Non irritating to the pulp or gingiva
2- Does not interfere with the setting of the final restoration
3- Easily placed and removed
4- Strong – short setting time
5- Radio opaque

Q**: what materials can be placed as temporary restorations?**

TEMPORARY MATERIAL	
ZOE	Conventional ZOE – [powder = ZO , liquid = eugenol] TYPE 1 = temp cement TYPE 2= permanent cementation TYPE 3= temporary restoration TYPE 4= liner ** provide pallative effect due to eugenol – but eugenol inhibits the polymerization of resin materials ** highly soluble + low compressive strength Modified ZOE → higher compressive strength Cotton fiber re inforced ZOE → less solubility + stronger and easier removal **Resin modified ZOE [IRM] → used as intermediate restorative material**
AMALGAM	If long interval is expected between caries control and perm restoration or if a significant portion of the occlusal or proximal surface is lost→ use amalgam because it will ensure better maintenance of tooth position + proper proximal contour
GIC	Anti cariogenic properties Used in caries control phase
TEMP INLAY / ONLAY / POST AND CORE	Materials : methacrylates -UDMA – bis acryls – bis GMA **Direct provisional for inlay/ onlay :** 1- After cavity prep wedges are inserted interproximally 2- Place desensitizing agent → Place inlay temp material of choice directly over the cavity 3- Lubricate the opposing tooth and ask the pt to bite down gently on the uncured temp material 4- After intial anatomy is given by pt biting → light cure for 30 sec Remove the temp inlay → finishing + polishing → try in → cement with temp cement [ZOE / ZO non eugenol]

Indirect provisional for inlay/ onlay :

1- Pre operative alginate or PVS impression is taken [if occlusal anatomy is harmed → build the tooth up with a temporary material then take impression]
2- Lubricate the tooth with water based lubricant
3- Place chemical cured acrylic resin material into the PVS / alginate impression made before cavity prep or you can use a putty index
4- Seat the impression with the temp material over the cavity and wait untill it sets → remove excess → finishing
5- Try in → cementation with temp cement [ZOE / ZO non eugenol]

** eugenol free temp cement is used if the final restoration will be cemented with resin cement.

** a gluteraldehye desensitizing agent [GLUMA] can be placed over the cavity to reduce post op hypersensitivity [it will not interfere with cementation]

Provisional post and core:

1- Poly carbonate/ cellulose crown former can be cut to fit the cervical portion of the tooth
2- Use an orthodontic wire / plastic post/ piece of paper clip inside the prepared canal
3- Over fill the crown former with self cure resin – resin will flow around the post inside the prepared canal
4- Remove the restoration and seat it several times before it sets to prevent it from interlocking with any undercuts
5- Cement with temp cement

Failure and repair of restorations

Examples of failed restorations:

1- Restoration causing pulpal pain or gingival irritation
2- Dislodged restoration / fractured restoration or tooth
3- Recurrent caries under or around the restoration
4- Restoration color and tooth color do not match
5- Restoration causing discomfort while eating or on occlusion

Q: what are the common factors that cause most restorations to fail?

1- Temp fluctuations → can lead to marginal percolation and microleakage
2- pH fluctuations → wear of materials
3- Saliva acts as a conductive medium → corrosion of metallic restorations
4- In adequate accessibility to the lesion → in adequate management
5- The mouth is full of microbes → enzymatic break down of bonding + recurrent caries
6- Forces in the mouth are not uniform [multiple forces in different directions – compressive , tensile, torsion etc] → creep and flow of amalgam, wear of composite and GI

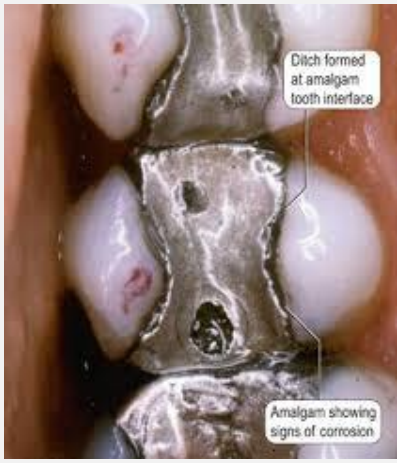
** ALL RESTORATIONS ARE BRITTLE EXCEPT CAST METAL RESTORATIONS

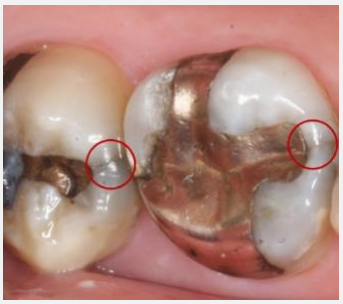
Common mistakes in restorative dentistry that lead to failure of restorations:

1- if there was any moisture contamination during placing amalgam → the Zn inside will cause hygroscopic expansion [delayed expansion after few days] → raised amalgam margins → marginal ditches + bubbles and voids on the surface
2- Not applying a suitable base underneath a restoration that is deep and close to the pulp might lead to pulpal irritation and pain.
3- if you don't cure composite well the uncured monomers will leach out and be replaced by water → composite becomes softer and easily degraded → stains and discolorations
4- if you don't match b/w the coefficient of thermal expansion [COTE] b/w the tooth and the restoration → marginal percolation and leakage
5- Inadequate thickness provided for amalgam → fracture
6- Improper CSM → material breaks
7- Not removing all discolored dentine in an aesthetic zone
8- Leaving unsupported enamel → fracture

Q :what can you do for a high risk pt that is non- complaint ? apply full coverage restorations

Failure of amalgam restorations

FAILURE TYPES	CAUSES AND NOTES
MARGINAL DEGRADATION AND DITCHING	Marginal ditching = a v shaped defect on the margin caused by fracture of the thin edge of the restoration **Causes :** 1- Improper CSM 2- Improper selection of the alloy [low cupper alloy = excess mercury] 3- Improper manipulation [you did not condense enough or you did not carve properly leaving flashes of amalgam on the margins] 4- Excess mercury [if low copper amalgam or not condensing properly] → mercuroscopic expansion [excess mercury will continue to react with the powder → expansion at the margins → ditching  **Management:** Replace the restoration with proper cavity design + porper selection of alloy and proper condensing and carving
ISTHMUS FRACTURE	Fracture of the narrowest portion of the cavity connecting the occlusal and the auxillary portions together  **Causes :** 1- Walls not perpendicular to the forces 2- Sharp edges and internal line angles 3- Absence of gingival seat or Insufficient thickness of amalgam [the axiopulpal line angle is not rounded] 4- Undercarving or misplacement of the marginal ridge → premature contact 5- Over carving amalgam , presence of voids or excess mercury 6- Plunger cusps 7- Sudden biting on a hard object or biting on amalgam before it sets completely ** isthmus width should be ¼ - 1/3 the intercuspal width + smooth transition from occlusal to auxillary portion + roundening the axiopulpal line angle to increase bulk of amalgam **Management** 1- Determine the cause of fracture and when it occurred in relation to restoration placement 2- Clinical exam : • Is the proximal portion still there or not ? • Is there recurrent caries proximally? • Design of the proximal portion if correct or not [width, depth , smooth transitioning from occlusal portion . wall orientation] **Treatment:** - **If the occlusal portion has good retention** → remove the proximal portion + prepare it properly and replace it with properly condensed and carved amalgam [without removing the occlusal portion] – cavity within a cavity

	- **If the occlusal portion is not retentive** → replace the entire restoration with good retentive features and proper design + good moisture control and condensation - **If the fracture happed because of heavy forces** → replace the amalgam with an Inlay / onlay At the same time you can do selective grinding of the opposing plunger cusp.
TOOTH FRACTURE	Can start as a crack untill it propagates into a fracture – because amalgam is not an adhesive restoration → uneven distribution of forces + cannot reinforce weakened tooth structure **Causes:** Improper case selection Improper cavity design [insufficient depth, wrong CSM, sharp angles that act as stress concentration areas] **Complications:** - Periodontal irritation - Hypersensitivity - Food impaction and recurrent caries **Treatment:** 1- Determine and eliminate the cause 2- Repair or replace the restoration 3- If non restorable tooth → extraction + replacement **To detemrine if you will repaire or replace the restoration you consider:** 1- Cause of the failure 2- Remaining tooth structure [restorability]  
DISLODGED RESTORATION	Rocking or totally dislodged restoration **Causes:** 1- Inadequate retention features 2- Tooth or restoration fracture 3- Recurrnet caries **Management:** Evaluate the cavity design + replace the restoration
POST OP SENSITIVITY	**Causes:** 1- Galvanic stimuli due to dissimiliar metals contacting 2- No varnish under the amalgam → open DT → microleakge [main cause] 3- Thermal stimuli conducted through metallic non isolated restorations 4- Premature contact Prevention: 1- Proper adaptation and carving to prevent premature contacts 2- Cavity varnish or bonded amalgam to seal DT and prevent microleakge 3- Apply bases and liners in deep cavities

RECURRNET CARIES **	**Causes:** 1- Improper outline [you did not include retentive areas, you did not free the contact which causes plaque accumulation , leaving undermined enamel or placing margins in areas of stress → ditch and caries] 2- In adequate caries excavation 3- In adequate manipulation [improper condensation, moisture contamination or using dry amalgam] 4- No proper contact and contour [marginal overhangs or open contact] → plaque accumulation area 5- Unpolished amalga → plaque retention  **Complications:** 1- Pulpal irritation / periodontal irritation 2- Displacemnet of the restoration 3- Tooth fracture **Management:** Replace the restoration + remove caries with proper design and adaptataion
GINGIVAL / PERIODONTAL IRRITATION	**Causes:**  1- Overpreperation of subgingival margins 2- Improper matricing and wedging → overhangs 3- Rough margins 4- Improper contour → open contact → plaque accumulation → gingival irritation + CAL and bone loss 5- Open margins due to improper condensation → plaque accumulation + recurrent caries ** best to check that you did proper proximal contour is taking a BW
AMALGAM DISCOLORATION	**Amalgam blue :** amalgam showign through enamel. **Tarnish :** loss of surface luster → adjusted by polishing **Corrosion:** actual disintegration of bulk of amalgam → depending on remaining structure you can repair or replace **<u>Amalgam tattoo :</u>** amalgam leaking into the gingiva → bluish discoloration of the gingiva 

Q: patient comes in after having a <u>recent amalgam</u> restoration with pain that occurs on cold and subsides immediately, what is the cause and what is your management? Pulp hypersensitivity and it will fade with time , because of the self sealing ability of amalgam → improved margins + pulp will heal with time – you can adjust any premature contacts to reduce pain.

- Spontaneous pain lasting for days → irreversible pulpitis caused by microbial involvement of the pulp → do RCT
- Pain on hot stimulation that persists → irrevrsible pulpitits → do RCT
- DULL pain several days after insertion of amalgam → due to hygrosocpic expansion of Zn containing amalgam due to moisture contamination
- Small marginal defects of amalgam can be repaired by GIC or flowable composite - just roughen amalgam surface before you place composite to provide mechanical retention

Failure of composite restorations

Failure type	Notes
Mechanical	**Bulk placement: leads to-** A. **Hypersensitivity :** When you place large increments of composite the lower part will not be cured properly → uncured monomers will cause hypersensitivity **B. Marginal leakage and Secondary caries:** After the composite shrinks → marginal gap C. **Gaps and voids →** make the material weaker and act as stress points that can later lead to fracture ** *only BULKFILL composites can be filled in large increments up to 4-5 mm* **Improper curing:** weakens the restoration + marginal leakage and water sorption **caused by-** A. Bulk placement B. Small increments in deep cavities that don't get cured properly C. LCU is not perpendicular to the cavity [if the LCU is at an angle → increase the distance between composite and the light source → improper curing] D. Improper LCU intensity **Prevention:** place small increments of composites , cure from all directions + use light reflecting wedges and matrix [this will also reduce microleakage and marginal gap formation] ** optimum polymerization occurs at a depth of = 0.5 – 1mm ** uncured composite will create channels for the uncured monomers to leach and those channels are replaced by water → composite swells a little bit to compensate for the polymerization shrinkage [but the water sorption will plasticize the composite and make it weaker + affect color stability] **Microleakage: caused by – improper bonding technique** 1- Polymerization shrinkage 2- Intraoral acidic changes → dissolve the margins [because it is unfilled resin] 3- Not washing the etchant properly 4- Over wetting or over drying the cavity 5- Very thin bonding agent ** occurs more when the cavity is mostly in dentine **Improper finishing and polishing:** Rough surfaces will accumulate plaque + stains , improper proximal margins can irritate the gingiva ** dry finishing and polishing can open the dentine margins at the dentine restoration interface
Esthetic	**Extrinsic discoloration:** Surface discoloration can occur if you don't finish and polish composite to remove the oxygen inhibition layer [uncured monomers] Maximum water sorption occurs in the first 7-10 days [high risk of staining by coffee, tea , coke etc..] **Bulk discoloration :** seen in chemical cured composites due to oxidation of the 3° amine [yellowing after 1-3 years of placement] **Marginal discoloration :** seen in light cured composites due to improper marginal finishing or due to polymerization shrinkage and leakage

	** light cured composites become lighter and more translucent after 24-48 hours due to decomposition of camphroquinine
Biological	**Under contouring** → narrow gingival embrasures → stagnation areas for food and plaque accumulation under the height of contour **Over contouring** → wide embrasures → excessive direct pressure of food during chewing → gingival trauma **Overhangs :** cause by improper matricing and wedging – can lead to gingival inflammation + pocketing and CAL - **Prevented by** : use a strong, well contoured, stable matrix + direct condensation forces towards cavity walls not the matrix

Q: Pt comes in after 1 day after placing a big composite restoration with severe pain on biting, what's your diagnosis and what caused it ? stressed tooth syndrome – mostly happens if you place composite and have very high bond strength but very high polymerization shrinkage → pull in the cusps and cause stress at the cervical region of the cusps → chipping and cracks cervically

Stressed tooth syndrome: pain on biting 1-2 days after curing composite due to polymerization shrinkage pulling in the cusps and causes stresses cervically

Repairing composite restorations

You need to replace the restoration if there is :

1- Recurrent caries
2- Pulpal pathology
3- Un acceptable esthetics

If the cause of failure was heavy occlusal load → switch to a stronger material like indirect restorations.

Overhangs or open margins → remove the defect then etch and bond new composite

- **Before finishing** – you can still add composite [it will bind by the oxygen inhibition layer]
- **After finishing** – the defective area needs to be roughened with a diamond stone or air abrasion with Al2o3 particles – area is etched and silane primer is applied is dentine is exposed – then apply adhesive and composite .

Failure of Glass Ionomer restorations

**** before placing GI → do occlusal analysis to see if there is heavy occlusal load on the tooth or not**

1- Wear and fracture if the restoration is placed under heavy occlusal load
2- Dehydration during setting → increased opacity + microcracks in the GIC
3- Water absorption during setting → increased translucency + weaker restoration

Prevention of GIC failure:

A. Avoid placing GIC in stress bearing areas [do occlusal analysis before placement]
B. Pre treat with 10 % polyacrylic acid and make sure the cavity is not too wet or too dry
C. Place GIC right after mixing [when the mix is still shiny]
D. Coat it with unfilled resin adhesive or petroleum gel. [if GIC is placed in control phase → don't coat]

Failure of indirect restorations

- **Most common failure =** bulk fracture **-** If bulk fracture occurs → replace the restoration
- **Minor defects can be repaired inside the mouth – large defects → replace the restoration**

Repair of indirect tooth colored restorations:

1- Rubber dam is a must**
2- The porcelain surface is roughened using diamond burs or air abraded using Al2o3 to increase micromechanical retention. → rinse and dry
   ** using course diamond burs can increase crack initiation through ceramics
3- Apply 10 % hydrofluoric acid gel on the porcelain surface for 60 seconds then rinse with water
   ** proper isolation to avoid soft tissue injury
   ** you can use 1.23 % APF gel for 10 mins as a safe alternative to HF acid
   ** zirconia cannot be etched because of the alumina content → sandblasting or laser etching
4- Silane primer is placed on the restoration and allowed to dry
5- 37% phosphoric acid is placed on any exposed tooth surfaces
6- Resin cement is applied on the restoration
7- restoration re cemented
   ** finished restoration is polished with rubber polishing tips and cups

Repair of indirect cast restorations:

1- if there are discrepancies in the margins → replace the restoration
2- if the restoration is retentive and intact and defect is small and accessible → repair with composite or amalgam

Dento – facial esthetics and esthetic restorations

In any esthetic analysis you need to focus on lighting : *Most esthetics parameters depend on light [brighter areas in a restoration will look more forward , darker areas will look more backward → giving depth and 3d effect of restorations]*

Macro esthetics	The face in general
Mini esthetics	Smile bordered by the lips
Micro esthetics	Teeth and soft tissue around them

Central dominance of central incisors: *since they are in more anterior position – they reflect most of the light*

- ***Normal length to width ratio of central = 1 to 0.8***
- ***Length = 10 mm and width = 7 mm***

Lines	
Vertical	***Horizontal***
Maxillary central incisors midline should coincide with the facial midline. ***Line A :*** *midline symmetry* ***Line B ;*** *interpupillary distance* ***Line E :*** *divide the face into 5 equal 5th [rule of 5]- each part is equal to the width of one eye* *Most people don't have coinciding dental and facial midline or coinciding upper and lower midlines*	• ***Interpupillary line :*** : gingival margin and incisal plane of maxillary teeth should be parallel to the interpupillary line • ***Occlusion line :*** connects the tips of canine teeth • ***Lip line :*** from one corner of the mouth to the other • ***Smile line / incisal plane*** ***Lines C :*** *divide the face in 3 equal 3rd [forehead, mid face , smile zone]*

Smile stages

- Stage 1 : closed lips – note shape / size and length of the lips
- Stage 2 : resting display – established by asking the pt to say letter M – **ideally 3 mm of the upper centrals and some of the lower Anteriors should show during rest stage**
- Stage 3 : natural smile
- Stage 4 : expanded smile

How do you check incisal display? Ask the pt to say the letter M – after pronouncing the letter M the pt will open their mouth slightly [incisal display]

Incisal display at rest depends on: Age, sex, and upper lip length

- Age: prominent smiles are seen more in young pts
- Females show more incisal display [incisal display for females = 3.5 mm , males = 1.9 mm]

Increased incisal display [more than 3 mm]→ caused by full **concave lips**

Decreased incisal display [less than 0.5 mm] → caused by thin **convex lips** or short teeth [attrition] or muscle relaxation due to aging.

In elderly : the distance between the nose and the upper lip line increases → lower incisal display

Normal lip mobility: 6-8 mm in full smile + shows the entire central incisor and 2-4 mm of gingiva

Hypermobile lips: overstreching of the lips while smiling → full incisors + gingival tissue show **[can be treated by Botox injections done every 3-6 months or lip repositioning surgery]**

Smile line [incisal plane] : The incisal edges of the upper anterior teeth that follow the curve of the lower lip. should be perpendicular to the midline and parallel to the interpupillary line.

Types of smile lines

- **Convex:** incisal edge of the central and the cusp tip of the canine lie on the same curved line.
- **Straight**: straight line due to attrition and aging
- **Concave:** reverse smile line - canines are longer than central incisors

Gummy smile: more than 3 mm of gingival tissue exposure on smiling.

Point of zenith of gingival margin = the most apical point of the gingival margin [it is always distal to the tooth midline] – only lateral incisors have the zenith and the midline coincide

Short teeth can be made to look longer by moving their gingival point of zenith more apically through surgery.

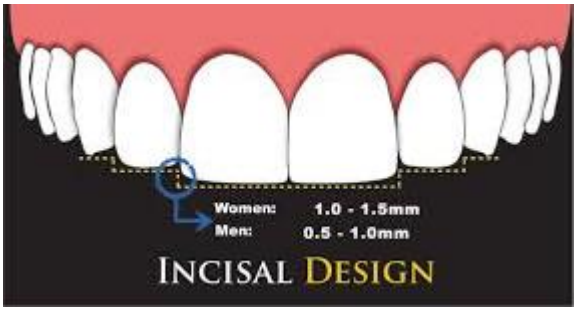
Normal gingival margin :

The canine and central have their gingival margin height of contour at the same level But the lateral has a slightly lower gingival margin height of contour → creates a triangle

If the lateral is displaced facially or in case of gingival recession → this will push it's gingival HOC more apically and destroys the esthetic harmony .

- Under contouring the cervical 3rd of a restoration → gingiva will grow down and cover the tooth
- Over contouring the cervical 3rd → gingival recession

Incisal edge of the canine is more apical than lateral incisors and lateral is slightly more apical than the incisal edge of the centrals.



- The difference in incisal edge location in males = 0.5 – 1 mm [the incisal edge of lateral is 0.5 – 1mm apical to the central incisor etc]
- The difference in incisal edge location in females = 1- 1.5 mm

<u>Buccal corridor =</u>the space that is displayed during maximum smiling [the space between the teeth and the internal part of the cheek. [narrow buccal corridor → more younger appearance]

Young teeth :

1- Lighter in color
2- More obvious perikymata and mamelons
3- Greater incisal embrasures

With aging:

Tooth becomes smoother + darker + flat incisal edge and minimal incisal embrasure

Golden proportion: the width of each anterior tooth is approximately 60% of it's adjacent [if the width of the lateral = 1 then the central is 1.6 times wider and the canine is 0.6 times narrower]

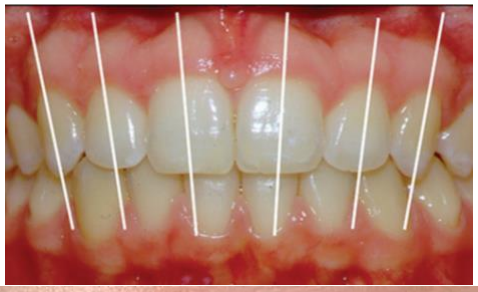
Upper incisors length is determined by:

1- Phonetics
2- Anterior guidance
3- Upper lip
4- Lower lip

To ensure correct upper incisor length = ask the pt to say V or F [the upper incisor edge should touch the lower lip vermilion border – wet line]

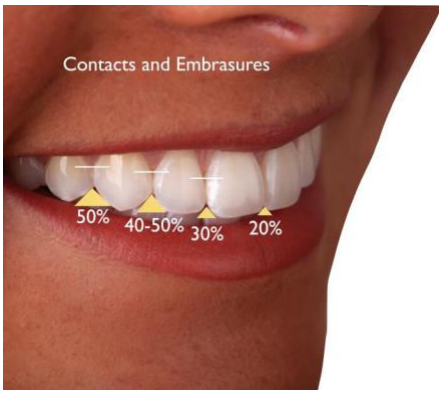
To ensure correct lower incisor length = it should be 1 mm behind and below the edge of maxillary teeth when pronouncing letter S

From anterior to posterior – teeth will have progressively increasing mesial inclination ***[teeth axis is slightly distal to the midline and it's distal inclination increases as you go posteriorly] .***



Changes in the contact areas

The smallest contact area is between the 2 centrals and it becomes larger as you go posteriorly [smallest contact point is between the lateral and canine] – the position of the contact point becomes more apical and you move posteriorly.-The contact point between centrals is more incisally and facially and become smore gingivally and lingually as you move posteriorly



Interdental embrasures is the smallest between the central incisors and becomes larger and wider as you move posteriorly.

Attrition will decrease the interdental embrasures.

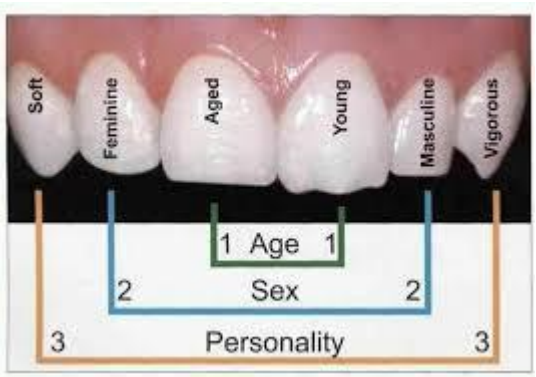
During restorations:

Old pt → decrease interdental embrasures

Young pt → increase interdental embrasure [this will make the teeth look more constricted]

Interdental embrasures

Feminine teeth	Masculine teeth
More rounded line angles More translucent More pronounced incisal embrasure	More angular and square incisal edges Less prominent incisal embrasures More characterization [craze lines + higher chroma] Darker and Less translucent
Young teeth	**Old teeth**
Lighter color More textured More pronounced incisal embrasures	Darker color Less textured [smooth surface and shows the underlying dentine] Less pronounced incisal embrasures



Color grading

Incisal 3rd	Mostly enamel [1.5 mm thick] → translucency
Middle 3rd	Thin enamel and tooth becomes more opaque
Cervical 3rd	Very thin enamel – most opaque region

*** greatest pigmentation within a tooth is found cervically – translucency is mostly in incisal edges / proximal surfaces / cusp tips → only enamel*

Lightest tooth = lateral *darkest tooth = canine*

- **Rough surfaces** → makes the tooth appear **opaque**
- **Smooth surfaces** → makes the tooth appear **more translucent**

> **To make the tooth looks smaller → place proximal line angles closer together**

> **To make the tooth look larger → place the proximal line angle farther away**

> **To make the tooth look longer →** add **vertical grooves / lines**

- **To make the tooth look wider** → add **horizontal lines**

** if the tooth is too long you can create a false CEJ on the tooth and add pink ceramic cervically.

Causes of esthetic derangement

Facial and skeletal problems [macro level]

1- Insufficient lip support:

Causes	Management
Skeletal problems [maxillary bone retrusion]	Orthognathic surgery
Insufficient teeth support	Direct / indirect restorations
Edentulous ridge / loss of teeth	RPD / complete denture

1- **Excessive lip support** → orthognathic surgery
2- **Open bite** → restorations / orthodontic Tx [if severe → orthognathic surgery]
3- **Mandibular prognathism / retrognathism** → orthognathic surgery
4- **Maxillary prognathism / retrognathism** → orthognathic surgery
5- **Asymmetry** → orthognathic surgery

Periodontal problems [mini level]

1- **Gingivitis** → do scaling and polishing + reinforce OH
2- **Gingival hypertrophy** → gingivectomy
3- **Gingival asymmetry** → gingival re contouring
4- **Recession** → gingival grafting

Tooth related problems [micro level]

1- ***Abrasion***
2- ***Erosion***
3- ***Attrition***

➡ Management :

1- Remove the cause
2- Protect the pulp
3- Direct / indirect restoration [depending on extent]

4- **Fractured tooth :**
   A. Simple chip → recontouring
   B. Extensive → Direct / indirect restorations / crowns

5- **High smile line :**

Causes	Management
Altered passive eruption	Gingival recontouring
Hyper active lips	BOTOX or lip repositioning surgery
Fibrous long frenum causing lip retraction	Frenectomy

Before

After

6- **peg lateral incisors** *:* they are mostly enamel → excellent bonding to composite / porcelain veneers or crowns .
if the tooth is short you can do crown lengthening + minimal prep at the gingival margin
most cases have gingival over eruption → gingival recontouring in needed first

7- **Diastema**

causes:

A. Macrognathia [large jaw]
B. Small teeth or slight protrusion
C. Low frenal attachment → frenectomy

Management :

- Small diastemas → resin composite
- Large diastemas → can be fixed with veneers or crowns [as long as this will not affect the height width ratio
- Very large diastema → ortho Tx

Discoloration of teeth

- **Extrinsic :** caused by external agents
- **Intrinsic :** occurs during tooth formation or after eruption
- **Internalized :** extrinsic stains that become internalized as a result of tooth defects / cracks

Nathoo classification of **extrinsic** stains	
N1	Color of the stain [chromogen] is similar to the color of the material that caused it ***Ex: Coffee, tea and wine stains***
N2	N1 food stains that darken with time Chromogen changes color after binding to tooth surface ***Ex: bacteria in plaque is colorless but it might produce a greenish discoloration***
N3	Colorless material that binds to the tooth and undergoes a chemical reaction to cause a stain. ***Ex: satins caused by carbohydrate rich foods , stannous fluoride , CHX***

Predisposing factors for extrinsic staining:

1- Enamel defect [pits, fissures, roughness etc]
2- Salivary dysfunction
3- Poor OH

Common extrinsic stains	
Coffee / Tobacco	Brownish black stains
Tea	Reddish brown stains
Wine	**Red stains**
Neglected plaque	Plaque will attract stains if neglected + produce chromogens itself • Greenish black in adults • **Orange in children**
CHX / silver ions	**Black stains**
Stannous fluoride / iron	**Brown stains**
Potassium permanganate	Violet black
Nickel / mercury/ copper	**Green stains**


Smoking stains


Food stain


Non-vital discoloration

If a single tooth is discolored → might be non vital tooth due to trauma → check vitality

Intrinsic stains	
Sickle cell anemia & hemolytic disease of the newborn	Yellow green stains
Tetracycline	Yellow – gray Mild = uniform yellow – gray, no banding Moderate = yellow brown – dark grey , slight banding Severe = blue grey banding m
Minocycline	Green grey or blue grey stains
Internal resorption	Pink discoloration
Pulpal hemorrhage	Bluish black

- Localized enamel hypoplasia → turner's tooth

Q: what causes the darker color of aged teeth / elderly?

1- Thinning of enamel
2- 2° and 3° dentine deposition
3- Prolonged exposure to stains

Fluorosis management:

1- Bleaching
2- Micro abrasion
3- Veneers

Conservative / esthetic treatments

When dealing with the esthetic zone:

1- Do smile self-analysis to know what is the Pt's exact esthetic CC.
2- Full set of extra and intra oral photographs.
3- Primary impressions and diagnostic casts [for wax up , better measurement of width and height of teeth, assessment of occlusion, better view of the lingual side of teeth and over jet & over bite]

** wax up on the diagnostic cast can be duplicated into stone then used to make a **[silicone index / vaccum tray]** You can fill the silicone index with temp acrylic material and do a mock up inside the pt's mouth [very useful if you are closing a diastema, or changing height and width ratios]

Management of discolored teeth treatment options

1- Bleaching: Using chemicals to oxidize the organic pigments

Indications	Contra indications
1- Discoloration due to aging 2- Mild fluorosis 3- Tetracycline stains – category 1	1- Pregnant or breastfeeding women ** 2- Heavy smokers of heavy coffee drinkers [the stains will return in 48 hours] 3- Dentine hypersensitivity [multiple cracks, caries or teeth with very thin enamel , young pt with large pulp chambers and thin dentine] 4- Teeth with extensive restorations [they don't have enough enamel for bleaching] 5- Emotionally unstable pt [they will never like the result] 6- Pts's allergic to the bleaching agents of bleaching tray resin 7- Hypoplastic spots [bleaching increases the contrast between the white spots and the tooth] ** 8- If the discoloration is because of amalgam [amalgam blue will be worse after bleaching] ** 9- Improper obturation

****composite restorations DON'T become lighter after bleaching and they become more obvious**

Bleaching	
Vital teeth	**Non vital teeth [internal bleaching]**
Chemical placed on the enamel – can only fix superficial discoloration Can be in office or at home.	Chemical placed inside the pulp chamber can lead to cervical root resorption ** [pinkish discoloration cervically]

Bleaching agents:

1- **Hydrogen peroxide** [works by forming (free radicals) hydrogen peroxide and reactive oxygen → oxidizing agent]
2- **Carbamide peroxide** [work by the high PH of ammonia causing bleaching]

Q: how does bleaching work? Bleaching breaks the high molecular weight of stains into smaller molecular weight particles that reflect less light.

In office bleaching [power bleaching] :

- Hydrogen peroxide (H2o2) + heat and light [very aggressive]
- Could damage the enamel & cause sensitivity and cause gingival burns

Procedure:

1- Clean the tooth surface with prophy paste [if you did scaling wait for a week because the root might be exposed]
2- Cover the gingiva with **liquidam** and cure it
3- Power bleaching

In home bleaching: mostly **carbamide peroxide** in a custom tray

Custom tray fabrication : https://www.youtube.com/watch?v=Gq1FHw5LdWU

1- Take impression+ Pour the impression to form a cast
2- create reservoirs on the cast using composite or silicone - to increase the oxygen ion presence on the tooth labial surface [you can't create reservoirs using wax because it will melt because of the heating]
3- Place a thin sheet of PVS in the vacuum former – the vacuum former will press down over the cast creating a custom tray
4- Trim the tray with a heated knife at the level of the gingival margin – smoothen the edges

2- resin infiltration: can be done for facial and proximal surfaces

Indications: you should have intact enamel surface and no cavitation

1- Incipient lesions [white spot lesions]
2- Hypocalcification spots

How it works: white spot lesions / incipient caries already cause porosities in the enamel , you increase this porosity by applying a strong acid then dry the surface with ethanol followed by application of low viscosity resin that will infiltrate the pores giving translucency and preventing caries advancement.

Procedure: https://www.youtube.com/watch?v=jKlwpe50PV8

1- Icon-Etch (15% hydrochloric acid gel) applied for 2 minutes
2- Icon-Dry (Ethanol) applied for 30 seconds
3- Icon-Infiltrant (low viscosity resin)applied for 5 minutes
4- Cure

3-Micro abrasion:

stain should be confined to the outermost superficial layer of enamel – for deeper stains you could do micro abrasion then home bleaching by carbamide peroxide

can be done using acid + abrasives or using aluminum oxide particles under pressure

Materials: strong acid to soften 5- 20 microns then abrasives to remove the superficial part of enamel.

- Hydrochloric acid + pumice or silica particles
- Phosphoric acid + pumice

Procedure: https://www.youtube.com/watch?v=wNzdGIhTaHY

Discoloration management:

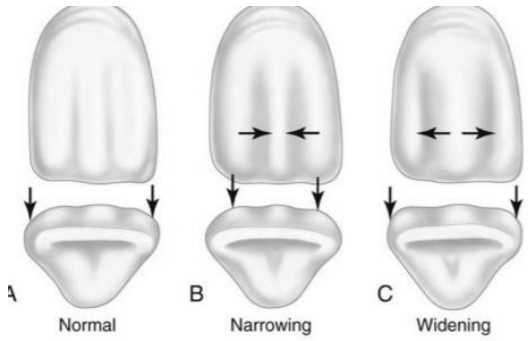
Bleaching if it fails → microabrasion or veneers

Rubber dam → The mixture is applied the stained surface of the enamel and using a rubber cup rub the surface with gentle pressure → rinse and check if you need to re do it [do not do it for more than 15 applications]

Cosmetic contouring:

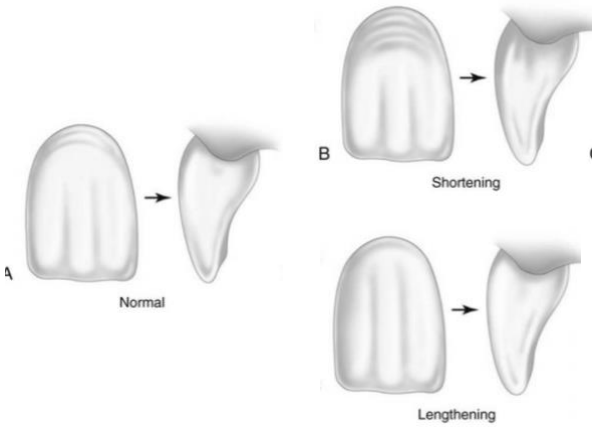
Indications	Contraindications
Slight alterations of tooth structure : > small chips > slight over lapping or extrusion > sharp edges and angles > uneven incisal edges	> Hyper sensitive teeth > Large pulps + thin enamel > Extensive crowding / extrusion > High caries risk [recontouring will create a rough surface → more susceptible to caries]

Optical illusion in conservative adjustments:



Adjusting tooth width:

- **Flatten the facial curve → wider tooth**
- **Enhance the facial curve → narrower tooth**
- **Move proximal lines laterally → wider tooth**
- **Move proximal lines medially → narrower tooth**
- **Move contact point labially → wider tooth**
- **Move contact point lingually → narrower tooth**
- **Horizontal lines → wider tooth**
- **Brighter proximal region→ wider tooth**
- **Darker proximal region → narrower tooth**
- **Smaller interincisal angle → wider tooth**
- **Larger interincisal angle → narrower tooth**



Adjusting tooth length:

- **Move cervical lines apically → longer tooth**
- **Move cervical lines incisally → shorter tooth**
- **Move incisal lines more incisally → longer tooth**
- **Move incisal lines more apically → shorter tooth**
- **Brighter cervical region → longer tooth**
- **Darker cervical color → shorter tooth**
- **Vertical lines → longer tooth**

Veneers

Indications	Contraindications
1- Incisal fractures in young pts 2- Attrition of anterior teeth 3- Correction of slightly mal positioned teeth 4- Diastema closures 5- Heavy discoloration 6- Deep bite	1- Bruxism / parafunctional habits 2- If less than 50% of enamel is remaining [enamel is needed for proper bonding] 3- High caries risk / poor OH **4-** Large restorations [less than 50% of enamel is remaining]

**** veneers can be partial or full coverage.**

1- **Direct veneers:**
composite veneers: using micro filled or nano filled composites [great polish ability + retain polish] – considered the **primary esthetic treatment in teenagers [growth expectations]**

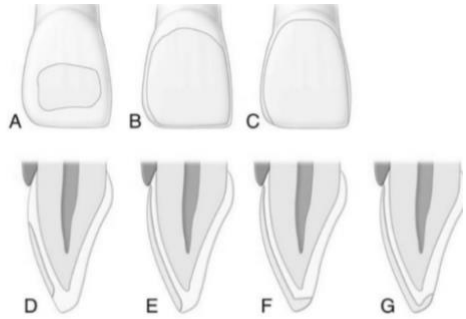
Advantages	Disadvantages
Single visit Minimal enamel removal No lab work [cheaper]	Limited esthetics Needs long chair time and good skills Needs enough enamel to provide strong bond Stain over time Can fracture or wear

2- **Indirect veneers :**
   A. **Composite**
   B. **Ceramic**

Advantages	Disadvantages
Less technique sensitive Lasts longer Better esthetics [contact, contour and shade]	Requires a specific tooth prep Expensive [lab work is needed]

Full coverage veneers:

According to incisal preparation	According to location and tissues involved
A. Window preparation B. Incisal Lapping Preparation C. But joint (Beveled) preparation	a. Extra-enamel design (No-Prep veneers) b. Intra-enamel preparation **c.** Dentin–enamel preparation



A/D: Partial veneer
B/E: Full veneer with window preparation design
C/F: Full veneer with butt-joint incisal preparation design
G: Full veneer with incisal-lapping incisal preparation design

According to incisal preparation:

1- **Window preparation:**
Indicated for maxillary canines in pts with canine guidance and heavy occlusal loads
Does not involved the incisal edge → less chance of wear of opposing teeth

2- **Incisal lapping preparation:**
Indicated when crown length needs to be increased or when incisal defect is severe and restoration is necessary.
Improves esthetics of incisal edge + easier to seat the restoration during cementation procedures, as there is a definite stop.

3- **Butt joint (beveled preparation) :**
Indicated when no defects exist along the lingual aspect of the incisal edge

According to location and tissues involved:

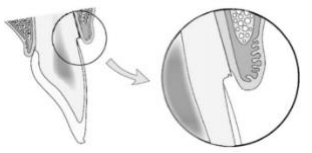
1- **Extra-enamel design (No-Prep veneers) :**
No preparation of the enamel – reversible procedure

Indications:
- Teeth that are under contoured
- Diastemas or interdental spaces are present
- Teeth that lost significant amount of enamel

Very thin veneer that is prone to fracture - Interproximal areas are difficult to access for proper finishing
** causes cervical over contouring → gingival inflammation , Plaque accumulation, secondary caries

2- **Intra-enamel preparation:**
Provide space for materials without over-contouring
Remove outer fluoride rich layer + Create rough surface to improve bonding
Has definite finish line (facilitate positioning and seating)

3- **Dentin–enamel preparation:**
Indicated only to mask the discoloration in the gingival one-third



**** if the pt has heavy occlusal load either use partial veneers or make sure you have enough incisal thickness.**

Veneer prep:

1- Depth guiding grooves prepared with depth cutting Burs (depth markers)
2- The preparation completed with a tapered diamond with rounded or tapered end.
3- At the proximal side, the preparation should be **facial to the contact point** (Except in case of diastema closure).

References

- Heymann, H., Swift, E. J., Ritter, A. V., & Sturdevant, C. M. (2013). Sturdevant's art and science of operative dentistry. St. Louis, Mo: Elsevier/Mosby.
- Craig, R. G., Powers, J. M., & Sakaguchi, R. L. (2006). Craig's restorative dental materials. St. Louis, Mo: Mosby Elsevier.
- Summitt, J. B. (2006). Fundamentals of operative dentistry: A contemporary approach. Chicago: Quintessence Pub.
- Young et al, The American Dental Association Caries Classification System for Clinical Practice: A report of the American Dental Association Council on Scientific Affairs, JADA 2015:146(2):79-86
- Pitts et al, ICCMSTM Guide for Practitioners and Educators,ICDAS Foundation, December 2014.

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