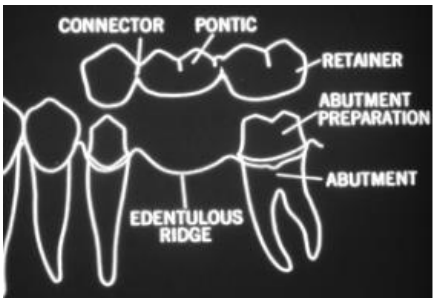
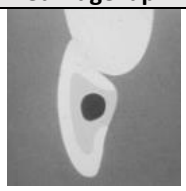
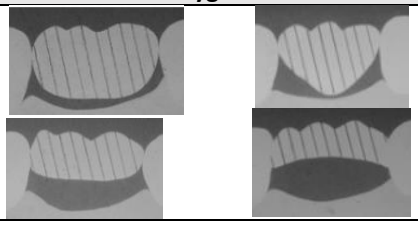
FDP connectors and pontics

- Consequences of missing teeth
  - Can cause movement of the adjacent or opposing teeth
  - Possible movements: drifting, tipping, rotating, extruding
  - Extrusion in unopposed molars: 24% in patients <25, 14% in patients >25
  - Can affect esthetics, VDO, occlusal changes, food impaction, and impaired hygiene
- Treatment options for edentulous spaces
  - No treatment
  - Orthodontics: shrink large gaps to allow prosthodontic solutions, or close them entirely
  - Prosthodontics: fixed dental prosthesis, removable denture, implant prosthesis
- FDP advantages
  - Patient acceptance
  - Esthetics
  - Comfort: functions like normal teeth
  - Splinting mobile teeth: reduces mobility of teeth, but doesn't address the underlying perio
- PRDP advantages
  - Lower cost
  - Multiple units and multiple edentulous areas can be addressed
  - Distal free end areas can be addressed
  - Replacement of gingiva, mucosa, and residual ridge
  - Allows load distribution
  - Oral hygiene
- Anatomy of a FDP
  - Abutment (tooth)
  - Retainer (crown)
  - Pontic: fake tooth that goes over the edentulous space
  - Connector: connects the pontic to the retainer. Weakest part of an FDP



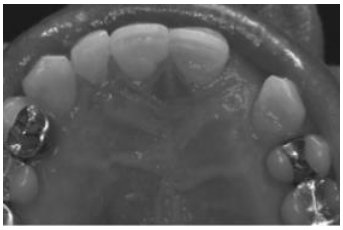
- FDP material
  - Can be metal, metal ceramic, ceramic, lab processed composite, fibre reinforced acrylic/composite
  - Fibre reinforced composite is only used in medically compromised older adults needing esthetic anterior tooth replacement
- Pontic design

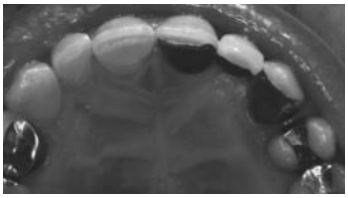
	Ovate	Modified ridge lap	Hygienic
			
Anterior zone	-Used in anterior zones with a broad ridge and extraction socket evident -Gives good contour for implants	-Has one concavity -Floss can reach all surfaces -Typical and most common pontic for anterior	-Not used
Posterior zone	-Not used	-For esthetic regions like the premolars	-Top left: conventional -Top right: bullet. For cases with knife edged ridge -Bottom left: high and dry -Bottom right: perel/arch. For gold alloys

  - In the posterior region, either be >3mm away from the ridge, or touch it. Having a small gap will only trap food and cause a hyperplastic gingival response

- Connector design
    - In the anterior region, the B-L thickness of the connector is the limiting factor
    - In the posterior region, the cervical-apical thickness of the connector is the limiting factor
    - In general, you want the connector to be $9mm^2$ (3mm x 3mm)
    - There are esthetic and hygienic limitations to how big we can make the connector
- FDP statistics
    - 74% after 15 years
    - Caries is the principle reason for failure for all crowns and bridges
    - 2% of bridges on sound abutments failed due to loss of retention after 6.4 years
    - 3% of bridges on periodontally involved abutments failed due to loss of retention after 4.5 years
        - Periodontally compromised teeth have more mobility → lever-type of stress applied on bridge → causes failure of the cement → loss of retention
    - 3% of vital abutments fracture, but 35% of non vital abutments fracture
    - Endo treated teeth, distal terminal abutment teeth, mandibular teeth, and >50% attachment loss teeth are at the greatest risk of bridge failure
- Provisionalization
    - Can be prefabricated or a vacuform
    - Finish the margins and also notch the connection area, to leave room for the papilla
    - The narrower we make the pontic, the easier it is to clean

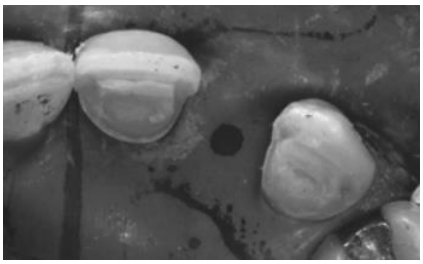
Resin bonded FDP's





- What it is
    - Minimal prep is made on the lingual surface to allow a metal plate to bond to it
    - The lingual metal plate supports the pontic, which is tooth coloured
    - Commonly referred to as a Maryland bridge
    - Advantages
        - Conserve tooth structure
        - Supragingival margins
        - Ease of seating at cementation
        - Pulp vitality testing still possible
        - Decreased laboratory cost
- Mechanics
    - We can't use light cured resin because it won't penetrate through the metal
    - The metal is "etched" via electrolysis, to mimic etching with acid
    - Then, the metal is bonded to the tooth using a self cured resin
    - Extra retention is gained by prepping the abutment teeth with rests or proximal boxes
    - Ceramic is not used due to thin form, it has a high risk of fracture and short life span
- Indications
    - Avoiding crown preps in young patients with large pulps
    - Avoiding invasive crown preps in virgin teeth, just to add 1 pontic
    - Healthy abutment tooth on either side
    - Small edentulous span
    - Non dislodging occlusal forces (like maxillary anteriors are usually pushed buccally, not dislodging the metal)
- Contraindications
    - Insufficient tooth surface area
    - Structurally weak teeth: would prefer a traditional crown prep instead
    - Mobile teeth: if one abutment is mobile, it creates a cantilever force and break the cement
    - Parafunction
    - Esthetics: could change the shade of the abutment, with the metal backing. Especially in incisal region
    - Base alloy sensitivity

- Retention
    - Macromechanical
        - Tooth: boxes, grooves, pins, parallel axial walls
        - Framework: perforations, meshwork, undercuts
        - Perforations in the metal framework used to be done, but has proved unreliable
        - Prep will mimic a 3/4 crown
    - Micromechanical
        - Framework etching (acid etch or electrolysis), micro-etching (sandblasting), tin plating, silicoating
        - Silicoating involves baking silica on to gold alloys, which then allows it to be compatible with bonding
        - None of these methods have proved to be much better than etched metal
- Anterior preparation design
    - Fine chamfer (just like a crown prep) for the entire lingual surface
    - Chamfer can be brought up to the buccal line angles, but this may be result in poor esthetics
        - It is better to stop the chamfer before the line angle and make a cingulum rest seat instead
    - Groove the proximal surfaces of both abutment teeth
        - These grooves must be parallel to make the restoration draw
        - Gives the restoration only 1 path of insertion, which is ideal
    - Additions: ledges, pins

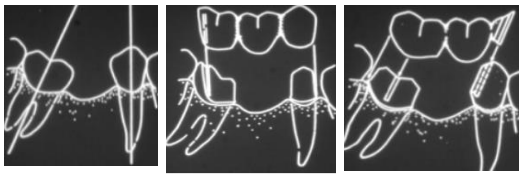


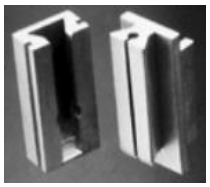
- Posterior preparation design
    - Fine chamfer on the entire lingual surface
    - Occlusal rests on both M + D of both abutment teeth
    - Proximal extensions to ensure 1 POI
    - Proximal boxes (like a class II amalgam) → relies on fit + composite on top, rather than trying to bond metal to teeth

- Sequence of appointments
    - Diagnosis, treatment plan, consent
    - Tooth preparation, impression, provisional
    - Framework try-in, shade selection (if necessary)
    - Final try-in and bonding
- Bonding steps
    - Metal framework: microetch, silanate, and resin bond
    - Tooth: isolate, pumice, etch, resin bond
    - Will need to use a self cure or dual curing cement
- Complications
    - Bonding failure
        - 22% after initial debond, 40% after re-bond, 60% after second rebond
    - Graying of abutment teeth (keep incisal edges away from metal)
    - Caries, periodontitis, gingivitis, pulpitis
- Survival statistics
    - Year by year survival: 89% → 84% → 80% → 74%
    - 10 year survival can be 95% with proper technique, use of pins, ledges, and grooves
- Success factors
    - Small edentulous span
    - Retentive preparation design
    - Base metal alloys (nickel chromium)
    - Metal preparation
    - Resin bonding procedure

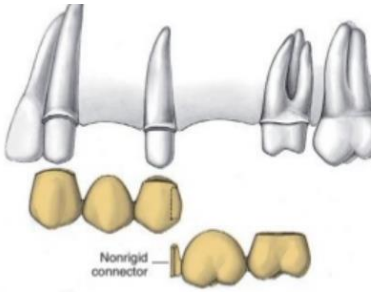
FDP biomechanics

- Abutment selection
  - Crown to root ratio: 1:2 is ideal, 2:3 is good, 1:1 is the minimum
  - Roots: divergent and multiple rooted teeth are ideal, round roots are not good
  - Periodontally compromised teeth can be used as abutments, but it is up to the clinician to determine
    - Needs excellent perio maintenance, plaque control, and supragingival margins
- Pericemental area
  - Ante's law: the attachment area of the abutment teeth must equal or be greater than the area of the teeth being replaced. Basically, root surface of abutments $\geq$ root surface of replaced teeth
  - However, this is actually not true. Clinically, bridges last many years even when this criteria is not met
  - How about using multiple abutment teeth for a pontic?
    - Benefit: distributes force
    - Considerations: rotational force of abutments, teeth are actually curved in an arch, it is difficult to get all the abutments to draw, must preserve the papilla between 2 adjacent abutments
- FPD strength
  - Deflection = (pontic length)^3
    - A 2 pontic bridge will deform 8x as much as a 1 pontic bridge
  - Deflection = (occluso-gingival thickness)$^{1/3}$
    - Decreasing the connector's thickness by ½ will cause a bridge to bend 8x more
    - Ideally, you want the connector to be 3x3mm, but you can get away with 2x3mm
- Cantilever FDP
  - What it is: one abutment tooth supporting a pontic attached to its mesial or distal surface
  - Requirements: good C:R ratio, healthy abutments, obeys Ante's law
  - Nowadays, a lot of these cases will be treated with an implant
  - If a cantilever is to be used, then it should be under light centric contact and no contact on excursions
  - Common cantilevers
    - Canine as an abutment with a pontic on the missing lateral
    - 2 premolars as an abutment for the first molar. However, the molar abutment must be premolar sized
    - In general, avoid distal cantilevers
- Tilted abutments
  - Hard to get a proper path of insertion and teeth will not be loaded axially
  - Solutions
    - Orthodontics to upright the abutment
    - Use a proximal ½ crown on the tilted abutment (middle)
    - Telescoping crown/retainer
    - Attachments (M and D portions are 2 pieces cemented separately) (right)
    - Non rigid connector





- Types of attachments
  - Precise attachments (pic): milled from factory, no degree of freedom, has to be soldered to the crown and pontic ($$)
  - Non precise attechments: some degree of freedom, made out of plastic then cast into metal
  - Allows parallelism
  - Non precise attachments act as a "stress breaker" → slight degree of freedom reduces excessive stresses
  - May have poor esthetics (avoidable if you give the lab enough space) and some compromised retention
- Pier abutment FDP
  - Abutment – pontic – **abutment** – pontic – abutment
  - There is a non rigid connector on the distal abutment that acts as a stress breaker
  - There is debate regarding its distribution of forces, mobility, and retention

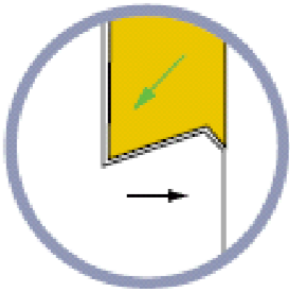


- Attachment risks
    - Inadequate root dimensions and prosthetic dimensions
    - Inadequate crown to root ratio
    - Mobile abutment teeth
    - Tooth structural, periodontal, gingival, and endodontic conditions
- Attachment complications
    - Increased treatment complexity, communication with lab
    - Increased time and cost
    - Increased maintenance
- What do you do if your metal bridge does not have a passive fit?
    - Section the metal bridge at one of the connectors
    - Fit the mesial and distal abutments on as separate pieces
    - Use GC pattern resin (self curing flowing acrylic resin) to glue the mesial and distal pieces
    - Allow the pattern resin to set
    - Remove the glued bridge, and check again for passive fit
    - If it fits well, then send it to the lab to be re-cast in that orientation

Complex composite

- Ideal preparation
    - No unsupported enamel
    - Smooth walls and margins
    - Minimal bevels on buccal/lingual cavosurface margins (don't use a bur, use a hand instrument)
- Sectional matrix systems
    - Should establish the interproximal walls of the restoration without needing burs or finishing strips
    - Should produce a smooth surface
    - Re-establishes the contact and proper embrasures, unlike a Tofflemeyer
    - Sequence: etch, prime, bond → place matrix → wedge → place ring over surface you will restore
        - If 2 adjacent teeth are being restored, 2 of these assemblies can be used side by side
- Useful instruments
    - All instruments should be really well cleaned so that composite doesn't stick to it
    - Occlusal embrasure: use a hollenback carver
    - Packing composite into prep: use an amalgam condenser
    - Removal of flash: disk sander and polishers
- Composite placement in proximal boxes
    - Place composite <1mm thick around the gingival margins and cure
    - Build the buccal and lingual margins
    - Build composite to seal the axial cavosurface margin
    - Connect buccal, lingual, and axial increments using a thin layer of composite
    - When approaching the occlusal, don't push composite all the way to the interproximal. There should be a small gap left to establish the occlusal embrasure
- Composite placement in occlusal box
    - Once the proximal boxes are filled, then finish the restoration like a class 1
    - Place a 1mm thick layer of composite on the pulpal floor
    - Build cusp by cusp and add anatomical features like oblique or transverse ridges
    - Cure between increments
- Reasons for failure
    - Primary reason: poor gingival adaptation
    - Secondary reason: incomplete curing in the box

2 surface Tucker gold inlay preparations

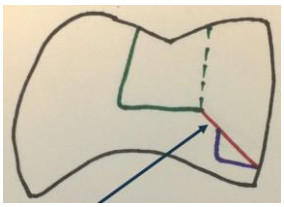


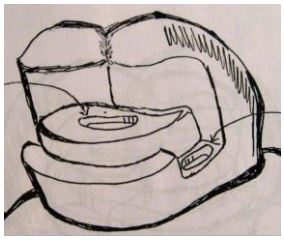
- Background
  - Conventional box and slot prep
  - Way better than scanned or milled preparations if done well
  - Standard Tucker restorations use type II gold, but type III can be used in heavier loads
- Preparation

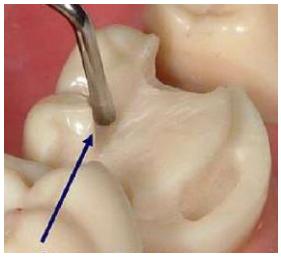
Tooth requirements	Material requirements
-Occlusal width ≤ 1/3 of intercuspal width	-Occlusal depth 1~2mm
-Pulpal depth 1.5~2mm	-Proximal depth (M-D) 0.5~1.5mm
-Smooth flowing, well defined margins	-Taper 6~10 degrees with no undercuts
-Bevelled gingival margin (0.5~0.75mm wide)	-Internal bevel at gingiva-axial line angle
-Flared proximal cavosurface margins	-Occlusal dovetail in 2 surface inlay
-Occlusal bevel in flatter anatomy	-Interproximal separation
-No undermind enamel rods	-Acute margins in metal

- Benefits of gold as a restorative material
  - Gold is malleable and will creep after function
  - Gold is not going to react
  - Coefficient of thermal expansion mimics teeth

Complex amalgam



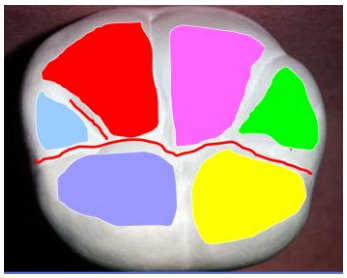




- Complex restoration
  - Replacement of one or more cusps
  - Relies on proper retention form, resistance form, and convenience form
- Retention
  - Amalgam: convergence of walls, proper orientation of slots
  - Composite: relying on bonding, with parallel or slightly divergent walls
- Complex amalgam
  - Prep design
    - Green = previous preparation
    - Blue = lingual shoulder prep
    - Red = fracture line (no need to remove the entire fracture)
    - Make sure the thinnest part of your prep is thicker than 1mm
    - All walls must be convergent to “lock in” the restoration
    - Prep should be parallel to occlusal table, to avoid condensing against a slope
  - Slots, troughs, and pot holes can all be used to increase retention
    - Safer and less stressful than pins
    - Ensure that a small condenser can fit
    - They can be made on the gingival or pulpal floors
    - Gingival slots should be placed 0.5mm into the dentin. Placing it at any DEJ will leave undermined enamel, which can chip off
  - Mechanical self threading pins
    - Can be used for added retention
    - Like the slots, they must be 0.5mm into dentin
    - Must be covered by at least 2mm of amalgam
    - Never under a centric cusp (can weaken amalgam and break off tooth structure with it)
    - Align the pin with the cavosurface margin, not the long axis of the tooth
    - Disadvantages: can craze/crack enamel, perforate pulp, transmits thermal changes close to pulp
  - Retention grooves
    - Also helps with retention
    - Must be able to fit the smallest condenser
  - Internal form could be built up with GI, which gives some thermal protection

- Fracture overview
    - Fractured cusps are frequently found in heavily restored teeth, and even unrestored teeth
    - Are generally due to frequent loading on sharply angled, medial facing cusp inclines
    - A fracture will start with tooth sensitivity and temperature sensitivity
    - Split begins at the pulpal floor at the buccal or lingual line angle and progress to the CEJ
    - The split may go through the pulp chamber or progress below the CEJ

- Treatment planning for a fractured cusp
    - Is the tooth restorable? Check radiographic, pulp, perio, occlusion, patient health
    - What's the function in the dentition?
    - What is the future treatment plan for the entire oral cavity?
    - What restorative material is best?
- Anatomy of the amalgam restoration
    - Buccal and lingual height of contours are in proper alignment and arch contour
        - Contacts should be in the middle third
    - Central groove is in proper arch alignment

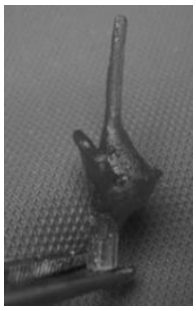


- Steps for carving
    - Establish height of contour
    - Establish lingual and buccal cuspal line
    - Establish central groove
    - Position the cusps (roughly)
    - Carve out the occlusal scheme
- Matrices
    - Tofflemire is the most commonly used. Gives a flare toward the occlusal
    - T-bands can also be used, but they give a cylindrical shape
    - Both matrices need to be burnished to create convex proximal contours

Cast post and core

- What is a core
    - Foundation restoration that restores sufficient coronal anatomy of a vital or endodontically treated tooth
- Ideal properties of a core material
    - Good compressive and flexural strength, similar coefficient of thermal expansion, dimensionally stable
    - Biocompatible, inhibits/resists caries
    - Resistant to leakage, minimal water absorption
    - Cast metal, composite resin, and amalgam are favored as core metals, but composite resin cores have more favourable fractures
    - GIC is not suitable due to its poor compressive and flexural strength
- Possible materials for a post
    - Metal: stainless steel, NiCr alloy, Ti alloy
    - Fibre reinforced: carbon fibre, glass fibre
        - Less likely to fracture the root, but is weaker than metal
        - Easier to remove
        - Allows adhesive bonding to tooth
        - Significant variations in quality – buy from a reliable brand
    - All ceramic: zirconia → long term prognosis unknown
- Possible designs
    - Parallel or tapered posts
    - Active (threaded like a screw, stresses radicular dentin) or passive (smooth) posts
- Survival of post + core restorations
    - Mean survival is 74 ± 43 months
    - Annual failure rate of 4.6%, with anteriors having 2x the failure rate than posteriors
    - More missing walls of the tooth had 2x increased risk of failure

- Ferrule
    - Vertical band of tooth structure on the gingival portion of the axial wall in a crown preparation
    - Resists spreading forces when a post is loaded occlusally
    - Primarily provides resistance form, but also some retention
    - Anything under 2mm of ferrule had significantly worse fracture resistance
- Preparing the crown
    - Remove existing restoration, caries, and unsupported tooth structure
    - Establish a finish line for core
    - Margins: metal cores will usually have a metal-ceramic crown on top. An all ceramic crown will have the metal show through, which is undesirable. Therefore, a 1.25mm buccal chamfer with 0.75mm elsewhere is ideal
- Root canal filling removal
    - Radiograph is taken to assess length and diameter of canal
    - GP is removed using a heated spreader initially, then deepen and refine the prep with a Gates Glidden drill
    - Leave 5mm of GP at the apex, removing 2/3 the length of the root, 1/2 the length in bone
- Preparing the canal
    - Parapost drill (size #5 in our clinic) is used to prepare the canal
    - The parapost drill sizes correspond to Gates Glidden drills by <u>colour</u>. Don't use the numbers
    - A minimum thickness of 1mm should surround the drilled canal
- Fitting the plastic parapost (to take an impression of the canal + crown)
    - Lubricate the canal with a water based lubricant
    - Mix the GC pattern resin (powder monomer + liquid monomer)
        - Dip a microbrush in the liquid, then dip it in the powder
        - As liquid saturates the powder, it turns a shiny red and the excess white powder will fall off
        - Will end up with a shiny blob of methacrylate after proper mixing



    - Paint the plastic post on all surfaces with this liquid methacrylate
    - Insert the plastic post into the prepared tooth
    - Bulk up more methacrylate material to the coronal part to form the "core"
- Once everything sets, refine crown preparation with pattern in place
    - Take the cast out of the tooth, and send it to the lab to be cast into metal
- Provisionalization
    - Provisional post is available, but in sim we used the plastic posts
    - An undercut may be incorporated into the provisional post, to lock in the integrity material
    - Some pattern resin can be used to keep the provisional post in place, if it's moving around
    - Integrity is loaded into a Vacuform and placed on the tooth with the post in place
    - Will make the core + crown in 1 step
    - Cement into tooth using eugenol based temporary cement (predominantly luting, not bonding)
    - Cement is only applied on the crown/core, not the post
- Cast try-in
    - Inspect, clean, disinfect
    - Ensure passive fit and proper fitting – can take a radiograph to verify
    - Fit can be checked by applying GC fit checker to the post
        - Insert it into the tooth and wait for it to set
        - Remove it and check where the material was removed → these are the high spots
        - Reduce the high spots
- Cementation of cast post
    - Clean the cast and the tooth
    - Cement using RMGIC or GIC (RelyX)
    - Dip the post in cement, and also use a lentulospiral file to spin cement into the canal
    - Seat using a slight rotating/twisting force to allow cement to escape
- In a real patient, you would refine the prep (if needed) after cementing the cast core. Then, a final impression can be taken for the crown. The patient will need a new provisional for just the crown

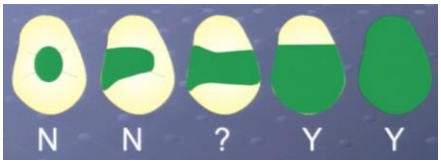
Prefabricated post and core

- Pre-treatment of tooth
    - Remove GP using heat, Gates Glidden as described previously
    - Shape the canal with a proper sized para post drill
    - Clean the canal space, etch with 35% phosphoric acid, rinse with paper points
        - Avoid NaOCl (bleach) and H_2O_2 (peroxide) as it weakens bond strength
- Placing the fibre post
    - Clean the fibre post with alcohol and air drying
    - Dispense some cement on to the post (comes out of a mixing tip, like integrity) and spread a thin layer all over the post using a microbrush
    - Place post into canal, and quickly wipe off the excess
    - Cure the top 2~3 mm using the curing light, the rest will chemically cure
    - 2 step or 3 step bonding systems all don't bond to dentin very well
    - Primary mechanism for cement is to act as a luting agent
- Restoring the core
    - Bond the tooth surfaces with 3 step systems, like regular composite restorations
    - Build up the core
    - Refine the restoration

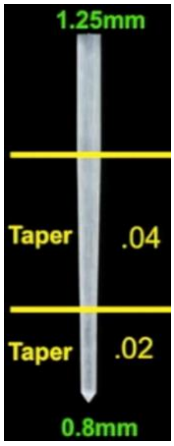
Foundation restorations – direct core and posts

- Core: a direct restoration that allows us to place an indirect restoration over it
- When does a core need a replacement?
    - Used to remove the core if any crown needed replacement, due to possible underlying decay
    - Now, we stray away from replacing cores because it risks trauma to the pulp
    - If there is no clear indication (caries, fracture, pain), then the core should be kept
    - If there is a marginal defect in the core but no signs of caries, then leave it
- Core materials
    - Anterior region
        - Enough tooth structure → RMGI is good, as it bonds to tooth
        - However, structurally weak teeth should avoid RMGI and use composite instead
        - Colours of the core (like amalgam) will only show through on translucent restorations
        - Ceramic and lithium disilicate restorations should be etched and bonded to a resin core
    - Posterior region
        - Amalgam has the best compressive strength, so it is an option. However, it doesn't bond to tooth
        - Composite resin is also an option
        - Small cores (lots of tooth remaining) can be built with RMGI, like Fuji II or Fuji IX
- Core should obey requirements of ferrule
    - Natural tooth structure should mostly contact the crown at the axial walls near the gingiva
    - Otherwise, it will put too much stress on the core material and risk fracture
    - Need ferrule all the way around the tooth, with minimum 1.5~2mm thickness
    - What if there is a small part of a tooth (<20%) that cannot get ferrule?
        - Commonly seen if the tooth had a previous deep MO/DO filling
        - One option would be dropping the crown margin even lower
            - Ferrule 1.5~2mm + BW 2.5~3mm = 4~5mm of tooth needed above bone
            - Can satisfy both ferrule and BW requirements by doing crown lengthening
        - The other option is to not have ferrule in this section: sometimes a good idea
- Post: a dowel that's used to retain the crown
    - Does not negate the need for ferrule
    - Posts do not reinforce structurally sound anterior teeth, and increase their chance of non restorable fractures
    - Have to consider when to use it. Posts will help retain the core, but they also increase the chance of fracture

- Indications for posts
    - Inadequate tooth structure to retain a core, but still has ferrule
    - Tooth is successfully endo treated, has a sound root, has adequate coronal dentin
    - Canine or incisor
        - Intact clinical crown that's endo treated → just fill the access with composite resin
        - Most tooth remaining, and endo treated → prefab post + composite core
        - Minimal tooth remaining, and endo treated → cast post + cast core (typically gold)
    - Bicuspid
        - Intact clinical crown that's endo treated → fill access (rare)
        - Most tooth remaining, and endo treated → amalgam/composite core + onlay/crown
        - MOD on a bicuspid, endo treated → debatable (weighing core retention vs tooth fracture), but these days likely we would do a fibre post with a crown
        - Minimal tooth remaining, and endo treated → prefab or cast post/core + crown



    - Molar
        - Minimal tooth remaining, endo treated → prefab post + amalgam/composite core + crown
        - Molars have a lot of dentin around the pulp chamber, so generally they can just have the core filled into the pulp chamber and not need a post to retain the core
- Post materials
    - Metal
        - Stainless steel or titanium alloy
        - Tend to be serrated on the surface, and come in standard sizes
        - Want to use size 4~5 sized parapost drills, because they fit a 1mm diameter post. Any post larger than this means you are unnecessarily removing dentin and weakening the tooth
    - Ceramic
        - Like metal posts, they come prefabricated with a corresponding drill
        - Very difficult to remove, and needs to be vibrated to loosen them
        - Originally made so decrease risk of discoloured roots
        - However, esthetic posts have now mainly been replaced by fibre posts
    - Fibre posts
        - Reinforced composite resin matrix
        - Can be carbon fibre, glass fibre, or quartz fibre
        - Carbon fibre was dark, so it is no longer used. Nowadays, glass or quartz is used
        - Typically come in tapered forms
        - Our clinic uses Bisco DT light post, which is quartz fibre
            - Comes with corresponding drills
            - Has a double taper: 0.02mm taper in apical, 0.04mm taper in coronal
            - Tooth coloured posts are good for esthetics, but hard to see when doing the core after cementing the post
            - This light post is tooth coloured at body temperature, but darkens when it cools down (like when you are drilling and spraying water on it)



- Post taper vs parallel vs threaded
    - Parallel posts have more shear forces than wedging forces, which reduces fracture risk
    - Tapered posts exert more force in the coronal canal, where it is wider and stronger. The post exerts a wedging force to the tapered walls
    - Threaded posts should be avoided, as it is hard to remove and highly increases chance of fracture
- Post + crown restorations
    - Good idea in theory, but very hard to do and has limitations in real life
    - When restoration needs to be replaced, it will be hard to take off and there will be a high risk of fracturing the root
    - The crown (external part) will need to be made slightly bigger to account for the cement, and the post (internal part) will need to be made slightly smaller
    - Casting this increase/decrease in size is difficult, and risks root fracture during cementation
    - Separate castings for the post and crown are preferred

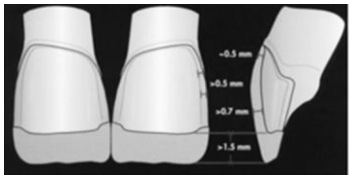
- Post placement procedure
    - Already covered
    - Initial radiograph should give you an estimate to how deep you need to drill
    - Stop 1mm short of this estimate, place a plastic burn-out post, and take another radiograph
        - Plastic is used because it's slightly radiopaque, but different than GP. Easy to see where GP ends
    - This will give you a more refined estimate of how much GP you want to remove
- Prep design
    - Core-tooth interface should be a butt margin, no bevel
    - Prep should have no undercuts
    - Antirotational elements (key way, pin holes) are not needed because cores are never in a perfectly round prep. This even applies to prepped canals. It will never be perfectly round, so rotation is not an issue
- Statistics
    - Overall, 91% of endos are successful, but drops to 82% if the endo and restorative treatment were inadequate
        - A previously untreated tooth will have 96% success, 86% if presenting with PA pathology, and 62% if the tooth is being retreated
    - Post and cores have a 90% success rate at 5 years, 83% at 10 years, and 68% for resected teeth at 10 years

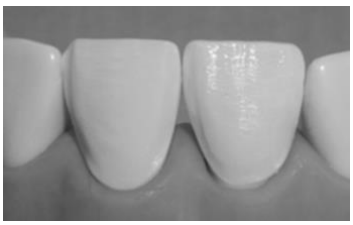
Porcelain laminate veneers

- Bonded ceramic restoration that restores the facial, incisal, and part of the proximal surfaces

Indications	Contraindications
-Structurally sound teeth in the esthetic zone, presenting with: -Tooth discoloration resistant to bleaching -Mild morphological variations in tooth formation (developmental or age related)	-Lingual involvement -Heavy occlusion on anteriors -Extensive morphological defects (should consider a full crown instead!)

- Advantages over crowns
    - Conservation of tooth structure
    - Reduced chance of pulpal involvement
    - Supragingival margins
    - Esthetics
    - Possibly lower lab costs and less bulky restorations, leading to less plaque
- Diagnostic workup
    - Photograph: smile, gingiva, interdental spacing, diastemas, colour
    - Test for occlusion
    - A wax-up is useful to see how much reduction is needed, and trying in a mock-up
- Preparation
    - Buccal: at least 0.5mm on gingival, 0.5 on middle, 0.7 on incisal
        - Reduction may not be needed if the tooth is already positioned lingually
        - Increase reduction near the proximal surfaces, just under the contacts
    - Incisal: reduce the teeth by 1.5mm in height and round off the edges so that they're smooth
        - The incisal surface could also be preserved, but reducing it by 1.5mm and having the butt margin is better at distributing force
        - A lingual wrap is also an option, but not ideal as it creates stress points in the ceramic
        - The lingual butt margin should not be in occlusal contact





- Provisionalization
    - Option 1: use integrity and vacuform to make the provisional veneer
    - Option 2: wax up the veneers, make temporary shells out of them
    - Bond the veneer using composite resin, not provisional cement
    - Multiple veneers can all be provisionalized as 1 unit

- Take an impression
    - Pack cord into the gingiva of the prepared teeth
    - Block out undercuts in other areas of the mouth
    - Lubricate other areas
    - Take impression with light body + medium body in a custom tray
- Shade selection
    - Ceramics are translucent, so you will have to provide an underlying stump shade and an overlying final shade
    - Give lab as much info as possible, regarding certain opacities or areas of spots
- Material selection
    - Feldspathic porcelain (layered): the most esthetic, best translucency, but weak
    - Leucite reinforced pressed ceramic (IPS Empress): good esthetics, poor strength
    - Lithium disilicate (Ivoclar Emax): is becoming more popular in favour of IPS empress

	Elastic Modulus (GPa)	Thermal Expansion ($x10^{-6}/K$)	Tensile Strength (MPa)
Enamel	80	17	10
Feldspathic Porcelain	60-70	13-16	25-40
Dentin	14	11	105
Hybrid Composite	10-20	20-40	40-60
			Magne & Belser, 2002
Empress (leucite)	62	16-18	
e.Max (lithium disilicate)	90-95	10-11	

- Send impression to the lab to fabricate into veneers with the following Rx:
    - Please fabricate feldspathic porcelain veneers for #11 & 21
    - Double pour casts; first cast with individuals dies duplicated as needed
    - Mount in intercuspal position using enclosed mandibular cast
    - Porcelain [not] wrapping the incisal & etch with hydrofluoric acid
    - Maintain contours & length to match maxillary cast (enclosed)
    - Stump Vita B2 (no discoloration); Final shade Vita A3
- Lab fabrication methods
    - Layered feldspathic
        - Ceramic powder is applied in layers, with each layer being baked on
        - Process is repeated until desired veneer with shade is reached
    - Pressed ceramic
        - Veneer is waxed up and sprued like a regular full metal crown
        - Ceramic is pushed into waxed areas
        - Layering different shades is difficult as this process is labour intensive to repeat

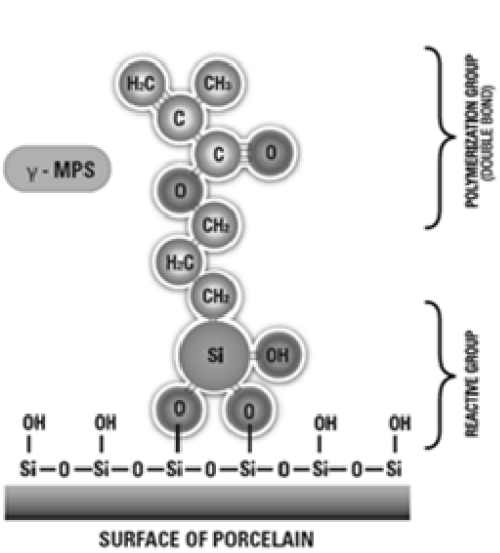
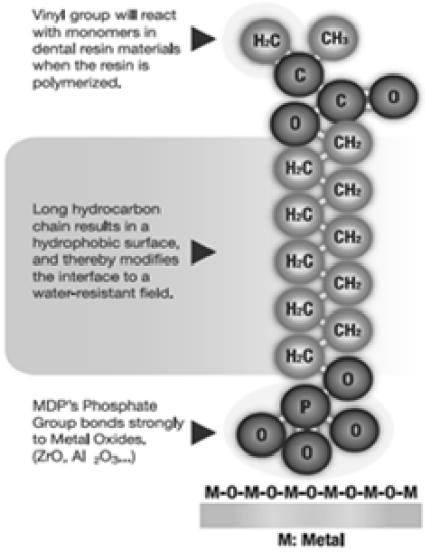
Cementing veneers and other indirect restorations

- Cements used

	Traditional (ZnP, GIC, RMGIC, SARC)	**Bonded (Adhesive + cement)**
Glassy Si-containing	-Not recommended	-Ideal
Alumina, Zirconia	-Possible	-Ideal

- Check the restoration on the die
    - Did the lab add in die relief?
    - Proper fit on die, good contacts, good occlusion, proper form, proper colour?
    - Identalloy sticker?
    - After this is complete, disinfect the restoration and examine the patient
- Patient preparation
    - Assess tooth and provisional for gingival health and any patient complaints
    - Local anesthetic is optional
    - Remove provisional and clean tooth with plain pumice
    - Isolate teeth, etch with phosphoric acid, and apply adhesive bonding resin

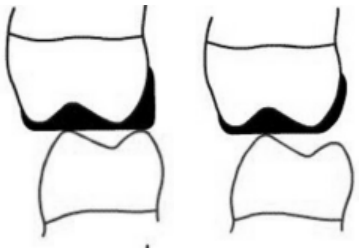
- Veneer preparation
    - If HF etched at the lab, check for over-etching
        - Over etched porcelain will have white salt precipitates
        - If this is the case, then use phosphoric acid for ~45s to remove the precipitates, and rinse the restoration
    - If not HF etched, then do it chairside using 9.5% HF acid (yellow) for 80~90s, or 4% HF acid (red/orange) for 4-5m
    - Clean the veneer with phosphoric acid, acetone, or 95% ethanol
    - Silanate the veneer
        - This turns the hydrophilic veneer into a hydrophobic surface
        - Comes in 2 part bottles or 1 bottle systems
        - A silinated ceramic restoration can be contaminated with blood and debris, but does not require re-preparing, as long as it's washed
- Bonding mechanism

Adhesive to porcelain	Adhesive to metal (zirconia)
	
-Silanating agent makes very strong covalent bonds with the Si atoms on porcelain -Other side of the silanating agent is hydrophobic, ready to bond to adhesives	-Metal priming agent forms bonds to the metal oxides (like on zirconia) -Other side is hydrophobic, allowing it to bond to adhesives

- Veneer try-in
    - Use water, glycerin, or try-in paste to see the veneers on the teeth first
    - Proximal contacts are assessed visually or with unwaxed floss if needed
    - Internal and marginal fit is assessed with occlude or fit checker
    - Emergence profile and form
    - Occlusion (only from clinical judgement, not actual occlusion as it's not cemented)
    - Esthetics and shade (if the shade is too off, it can be stained back or remade)
    - Patient approval
- Veneer cementation
    - Isolate tooth
    - Apply bond as per manufacturer's instructions
    - Apply the resin to the restoration, not the tooth
    - Seat the restoration with gentle finger pressure in a lingual and gingival direction
    - Check margins for proper seating
    - Remove excess cement and overflow
    - Cover with glycerin (air barrier) and light cure lingual and facial
- If there are multiple veneers
    - Start with the centrals first, just to establish the midline
    - Then, all other teeth can be placed respective to the centrals
- Check occlusion and make any adjustments or finishes as needed

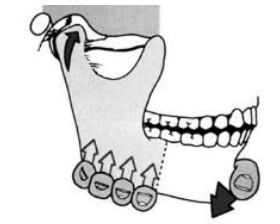
Occlusal appliances

- Artificial removable surface affecting the relationship of the mandible to the maxilla
    - Used to treat TMD's and bruxism
    - Protects restorative materials and remaining tooth structure in bruxers
- Types of appliances
    - Stabilization: most commonly used, and usually on maxillary arch
    - Anterior repositioning: disengages and relaxes muscles for TMD. Possible risk of overeruption
    - Bite planes: disengages and relaxes muscles for TMD. Possible risk of overeruption
    - Posterior bite planes: disengages and relaxes muscles for TMD. Possible risk of overeruption
    - Pivot appliances
    - Soft appliances: for sports functions (sports guard)
- Stabilization appliance (AKA night guard)
    - Retention is from buccal embrasures, clasps are generally not necessary
    - Smooth and does not impinge on soft tissues
    - All occlusal surfaces are covered and occlude with a flat splint surface
    - Made from heat or cold cured acrylic
    - To preserve anterior guidance, it can be achieved with canine ramps
- Occlusal contacts
    - 2 cusp contacts (left): is more stable, but harder to achieve. Even harder in teeth that are malpositioned
    - 2 cusp contacts will narrow the tongue space
    - 1 cusp contact minimizes need for palatal extension, and allows for movement of mandibular teeth
    - In intercuspal position, the cusp tips should be aligned with a flat surface
    - In lateral excursion, the posterior teeth should disclude due to anterior guidance



- Fabricating a stabilization appliance
    - Assess if the patient has interferences in their occlusion
    - Take alginate impressions
    - Take bite registration <u>at the vertical dimension intended</u> with the appliance
    - Get lab to fabricate it in heat cured acrylic resin
        - Palatal extension: 4~5mm past the gingival margin
        - Buccal extension: into the embrasures and just over HOC
        - Occlusal surface: should be smooth and anterior ramps built in
    - Clasps and braided wire strengtheners could be added, but usually not necessary

- Obtaining jaw relation record
    - CR: position where condyles are in their most anterior-superior position
    - Dawson method is an easy way to reproduce CR
        - Both thumbs placed below the patient's lower lip
        - Fingers placed along border of mandible
        - Stabilize the head and move the mandible
    - Deprogrammers (Lucia jig, cotton rolls, leaf gauge) are useful, as they remove memory
    - Bite registration material should be soft enough to prevent jaw deflection, but set rigidly and not distort



Gentle torqueing force

- Example prescription
    - Please construct a maxillary occlusal bruxing appliance
    - Use a semi-adjustable articulator with the supplied occlusal record to mount the casts
    - Overlap 30% of the buccal surfaces of maxillary teeth below height of contour for retention
    - Extend the lingual border 10mm from the gingival border without impinging on any soft tissues
    - Span edentulous areas with ridge-lap design
    - Use flat cusp-tip contacts that are adjusted so that they are evenly-distributed around the arch
    - Use canine ramps to disclude posteriors in all excursive movements
    - Fabricate in hard, heat, and pressured-processed acrylic
    - Finish highly-polished except for the occlusal contact points and fitting surface

Occlusal schemes and occlusal rehabilitation

- Goals in occlusal rehabilitation
  - Establishing a stable mandibular position (ICP = CR)
  - Establishing an esthetic and functional occlusal plane
  - Establishing the desired occlusal vertical dimension
  - Design of the static occlusion (occlusal contacts, max/mand intercuspation, tripodization, parallelism)
  - Design of the dynamic occlusion (occlusal guidance, group function, mutual protection, atraumatic occlusion)
- Mandibular position
  - Reproducible stable mandibular position where the articular disc is positioned in the antero-superior location
  - No evidence for one method being superior for obtaining desired mandibular position
  - Bimanual Dawson method is more reproducible to produce CR
- Occlusal plane
  - Draw a line from the incisal tips of maxillary anteriors, and it should follow the curve of the lower lip
  - Biting force and masticatory efficiency is affected by steepness of the occlusal plane
  - Compensating curves of Wilson and Spee facilitate a balanced occlusion in complete dentures
    - Steep curve → pronounced overjet + overbite → posterior disclusion and anterior guidance
  - In a natural dentition, the most significant feature of an occlusal plane is related to esthetics, not function
- Interocclusal contact
  - There are 2 occlusal schemes: cusp-embrasure and tripodization
    - Cusp-embrasure: in a natural dentition a cusp contacts either a marginal ridge or a fossa
    - Tripodization: a working cusp makes 3 contacts, which may help with improved stability or function
  - It is not known whether one scheme is superior over another in preventing food impaction, preventing lateral posterior forces, and promoting axial forces. A normal dentition has some of both schemes
  - In implant occlusions, a single cusp-fossa contact is used, not cusp-marginal ridge
  - It is ideal to have heavier contacts in the molars, with evenly distributed forces bilaterally
  - Removable prosthetics
    - 2 types of teeth: anatomic (mimics natural teeth) and non-anatomic (flattened occlusal surfaces)
      - Non anatomic: useful in crossbites, easier to manage in reverse lingualized occlusions
      - Lingualized anatomic: gives single contacts on molars and exaggerated curves of Wilson
    - No long term studies have been conducted to see which occlusal scheme is desirable
    - Anatomic teeth are purported to have better mastication
    - Patients prefer anatomic teeth but due to esthetics, not function
    - Occlusal schemes that promote protrusive and latrotrusive balance are preferred
- Occlusal guidance
  - Canine guidance is the preferred scheme to protect posterior teeth in excursive movements
  - No studies have shown one scheme to be superior, but wear is decreased when there is canine guidance
  - Canine guidance is also easier to produce in prosthetics
- Occlusal vertical dimension and occlusal support
  - Decreased masticatory efficiency is associated with loss of occlusal contacts in the posterior
  - Perceived disability and TMD does not correlate with reduced contacts in the posterior
  - Lack of posterior contacts may affect subjective function more than objective function
  - Occlusal vertical dimension changes need time to accommodate
  - OVD changes need to account for esthetics, neuromuscular adaptation, and interocclusal spacing
- Classification of occlusal schemes
  - Type 1 = ideally and minimally compromised
    - Pathology in <3 teeth in a sextant, no pre-prosthetic therapy needed, contiguous arches
  - Type 2 = moderately compromised
    - Anterior guidance intact, only localized pre-prosthetic therapy, pathology <4 teeth in a sextant, limited to 2 sextants
  - Type 3 = substantially compromised
    - Major therapy (but no change to OVD), pathology 3~4 teeth in a sextant in ≥2 sextants
  - Type 4 = severely compromised
    - Major therapy (including OVD change), pathology >4 teeth in a sextant in ≥3 sextants

Occlusal registration

- When is it needed?
  - Occlusal instability when casts are put in intercuspal position
  - Lack of arch tripodization
  - CR recording desired (de-programming)
  - OVD change planned
  - Partial or complete edentulism
- When they are not needed
  - Mounting a single porcelain veneer crown with enough ICP stability
  - Single implant crown with enough ICP stability
  - Bridge with a stable ICP and intact canine rise (however, an articulator with lateroprotrusive capabilities may be necessary)
- Futar
  - Popular bite registration material
  - Don't need to have an excess all over the mouth. A simple occlusal stop can be trimmed and used as an adequate bite registration
  - Can be coupled with provisional restorations when doing sequential restorations
    - Image on the right – 3 crown preps side by side
    - Provisionals are placed on the 2 mesial crowns to give initial stability
    - Then, futar is placed on the last tooth to take the bite registration
  - Futar only needs to be applied in the area of the restoration, not the whole jaw
    - Applying futar in the whole jaw means you can't guarantee that the teeth are fully in ICP
    - Put futar only in the area of interest and ask patient to intercuspate all other teeth
- How to take registration when there is unstable ICP
  - Wax occlusal rims will be required
  - Made on working casts
  - Relined in mouth if necessary
- Occlusal registrations in patients planned for OVD changes
  - ICP will not suffice, as it will be changed
  - Get patient to bite in CR, irregardless of their ICP
  - Use the CR registration to mount the casts and make prostheses
- Complete denture occlusal registration
  - Will need CR record, not ICP (no teeth)

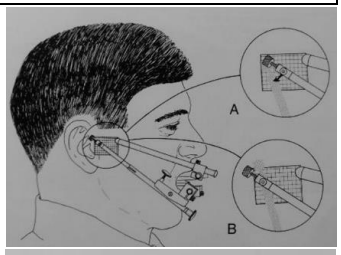
Articulators

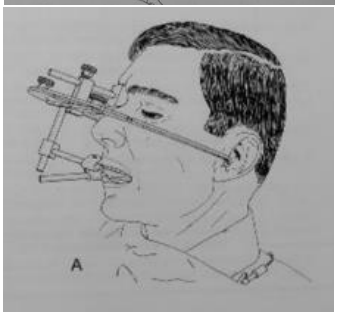
- Articulator: a mechanical instrument that represents the TMJ and jaws, to which max/mand casts can be attached to simulate some or all mandibular movements
- Articulators can incorporate any of these elements:
  - Horizontal axis of rotation
  - Condylar inclination and fossa components
  - Intercondylar distance
  - Bennett angle and medial wall
  - Incisal guidance
- Uses of an articulator
  - Diagnostic: diagnosing, visualization, assessing movements
  - Treatment planning: esthetics, wax ups, orthodontic setups, designing fixed restorations
  - In treatment: aid in developing restorations that are in occlusal harmony

- Classes of articulators

Class I – simple hinge	-Wait till we leave UBC, and this is all we will use -Can have significant differences in the arc of closure -Interferences on mesial inclines of maxillary teeth and distal inclines of mandibular teeth -Not recommended
Class II – average value	-Non adjustable with a fixed condylar inclination and Bennett angle -Movement unrelated to patient movement -Based on Bonwill triangle
Class III – semi adjustable	-Allows compensation for protrusion, condylar inclination, Bennett angle, and immediate side shift -Intercondylar width (110mm) is not adjustable -Can utilize static protrusive and lateroprotrusive records -Can accept an ear or facebow registration -2 basic groups: arcon (condyles on static base) or non-arcon (condyles on dynamic arch) -Generally uses average values, which give acceptable results -Intercondylar distance at 110mm -Immediate side shift at 0.2mm -Progressive side shift 7 degrees -Condylar inclination 20~30 degrees -Appropriate for single restorations, multiple restorations, FDP's, and removable prostheses
Class IV – fully adjustable	-Allows programming of all dimensions, including intercondylar width -Allows programming with a pantographic tracing -Only comes in arcon -Recommended for multiple restorations in opposing quadrants, full mouth reconstructions, and extensive occlusal pathologies

- Facebows
  - Registers the maxilla relative to the craniofacial anatomy
  - Allows maxillary cast to mount in similar position relative to the horizontal plane
  - Provides approximate measurement of intercondylar distance
  - Can be a kinematic facebow or an arbitrary ear/facebow
    - Kinematic FB's allow the true hinge axis to be recorded
    - Arbitrary FB's uses the bilateral EAM's to create an arbitrary horizontal axis, and the nasion as the anterior reference point





- Arbitrary facebows
  - Arbitrary FB's are simple, faster, and are reasonable accurate
  - Errors of 5mm in locating the transverse horizontal axis leads to an AP discrepancy of 0.2mm (negligible)
    - 56% of axes fall within 6mm of THA, which is good
  - If using arbitrary FB's, changes in OVD should be limited to 2mm or less
  - Any OVD adjustment more than 2mm will need a kinematic FB
- Errors
  - Overcompensating (programming the articulator shallower than actual) is preferable
  - This "negative error" means the restorations will be made with shallowed M/D and B/L cusp inclinations
  - Promotes disclusion of posterior teeth
- Summary
  - No articulator is perfect
  - None can record all jaw movements
  - None can reproduce all mandibular movements
  - Non can reproduce anatomy of TMJ

Intraoral scanners

- Classes of intraoral scanners
    - Scanning and milling: captures data, manipulates it, and mills out a restoration
    - Scanning only: captures data, then sends it to a lab to be made into a restoration
- Mechanisms
    - A/B: light is emitted through a slit, and only the data in the focal point is captured. This eliminates bad data and creates slices of information which is reconstructed on the computer
    - C: light is emitted as a mesh, and the camera captures the distortion in the mesh to gather data
    - D: a live video is captured by 3 cameras and constantly taking points
    - No mechanism is better than the other, and they are all generally the same. They all require a light source, a detector, and software to analyze the data

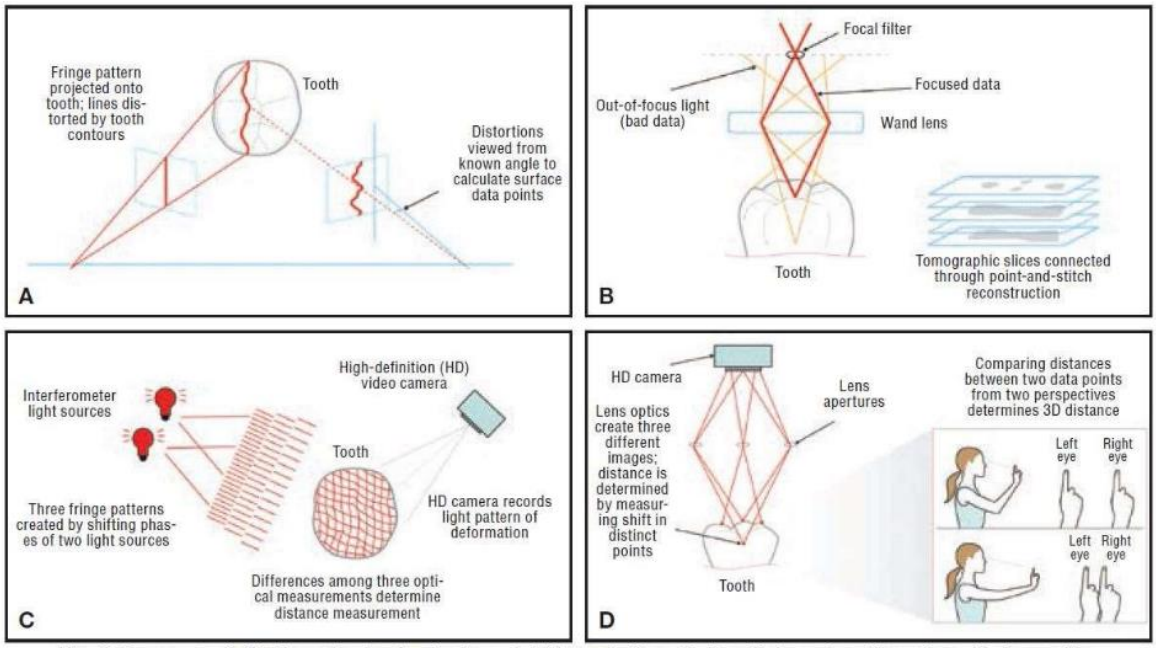


Fig. 3 Common digital imaging technologies. A. Triangulation. B. Parallel confocal imaging. C. Accordion fringe interferometry. D. Three-dimensional in-motion video imaging.

- Advantages of optical impressions
    - May reduce distortions associated with conventional impression materials
    - Clinically comparable to conventional impressions
    - No need to disinfect digital impression
    - Easier to store
    - Little or no gagging
    - Less costly (despite the large initial investment)
    - Can evaluate preparation in real time
- Real-time preparation imaging
    - Produces a magnified image
    - Can immediately assess: taper, occlusal clearance, path of insertion, quality of margins
    - Can modify the prep without having to bring the patient back
    - Can superimpose it with a “gold standard” prep and look at margins

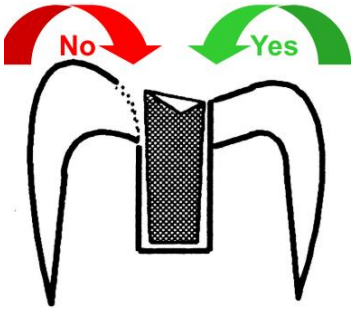
Digital dentistry

- CAD/CAM
    - Computer aided design and computer aided manufacturing
- CEREC

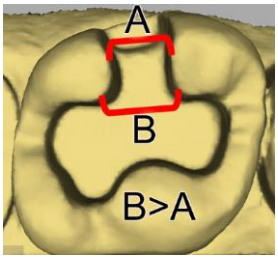
Chairside	-Allows one appointment from preparation to bonding of the final restoration -No contamination of dentin with provisional cement and gives an optimal bond -Could be sent to lab if desired
Economical	-Materials wise, the cost per restoration is 1/8 of an MCC crown -No need for provisional crowns, PVS materials, custom trays, etc -However, high startup cost (160K)
Restorations	-Primarily single unit posterior restorations (crown, onlay, inlays) -Also possible to do anterior crowns, veneers, long term FPDs, and implant crowns
Esthetic	-VITA shades are available -Could improve esthetics further by staining and glazing
Ceramics	-Feldspathic ceramic (Vita block) -Zirconia lithium disilicate (Celtra Duo) -Ceramic composite (Lava ultimate, Cerasmart) -Lab only: alumina and zirconia based ceramics -Leucite reinforced glass ceramic (Empress CAD) -Lithium disilicate glass ceramic (eMax) -Zirconia

    - Parts of a CEREC system
        - Acquisition unit: omnicam (camera), computer, monitor, software (updated annually)
        - Milling chamber (uses two 1.2~1.6mm diamond burs)
- Paradigm shift: analog dentistry to digital dentistry
    - Optical impressions are stored digitally
    - Same restoration can be re-milled with/without modifications
    - More than one restoration can be milled for the same tooth, for shade matching
    - However due to the size of the burs, they are limited to how much detail can be milled into the occlusal anatomy
- Case selection
    - Previously, gold was the material of choice
        - Allowed a conservative prep, predictable properties (never breaks), and less technique sensitive
    - However, CEREC has some advantages too
        - Esthetic demand
        - Biomimetic (conducts temperature slowly like tooth, not fast like gold)
        - Time saving (one appointment)
        - CEREC restorations are usually used as single units, and on posterior teeth
    - Contraindications of CEREC
        - Sensitivity to materials (not common with ceramics)
        - Uncontrolled bruxism
        - RPD abutments
        - FPD (ceramic will need large connectors and is impractical. We could consider zirconia though)
        - Limited patient opening
- Design steps
    - Fissure height: must be at least 1.5mm
    - Occlusion: tooth should be in light occlusion (blue colour)
    - Contours: should follow anatomical contours
    - Contacts: interproximal contacts should be present
- Impression taking
    - Similar to traditional methods, an isolated dry field is needed
    - Control soft tissues (retraction, hemostasis)
    - Bite registration is taken by a buccal recording of the 2 jaws biting down
    - Once scanned, the software assists in margination
    - Morphology of the restoration is made by the computer to generate best marginal fit, contacts, and proximal contacts. It uses a design database or correlation to pre-existing anatomy
    - Dentist can also modify the design

- Preparation design
  - Similarities to traditional preps: uniform reduction, smoothness, preservation of marginal ridges + oblique ridges)
  - The ability to bond will influence the design, but still keep traditional retentive and resistance features
  - Occlusal line angles have to be more rounded and cusp tips have to be rounded off
  - Strive to retain certain anatomic structures (marginal ridge, oblique ridges)

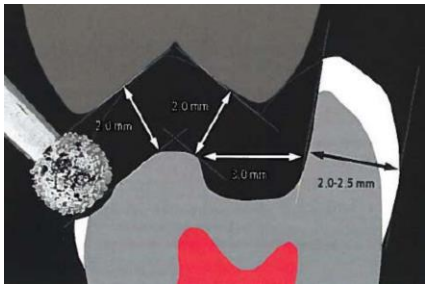


  - Box form
    - 90 degree cavosurface angles and butt margins
    - No bevels (unclear margins cannot be read by the software)
    - Rounded line angles
  - When to do cusp capping (covering the entire cusp with the restoration)
    - If there is less than 2mm of tooth support at the base
    - If the cavosurface terminates on a cusp tip, cover the whole cusp
    - If the tooth is endo treated
  - Ceramic requirements
    - Bucco-lingual width must be at least 2mm
    - Occlusal-pulpal depth: must be at least 2mm on supporting cusps. The central groove and non functional cusps can get away with 1.5mm
    - Proximal box: must be at least 1.5mm M-D and B-L



  - Walls
    - 6-8 degree divergent taper is optimal for adaptation and margin fit
    - Over-tapering leads to thinner occlusal margins and stress at the margin
    - Avoid steps in the wall, must be smooth from floor to occlusal surface
    - Must be widest near the center of the tooth (B>A)
    - Buccal/lingual walls (for crown preps) should have 2 plane axial reductions
  - Interproximal margins
    - Contacts must be open by 0.5mm so that the scanner doesn't connect to the adjacent tooth
  - Undercuts
    - There may be undercuts in the tooth after removing the old caries + restoration
    - Rather than removing healthy tooth structure to get a passive fit, some composite can be lined to get rid of the undercut and give bulk to the tooth

  - Buccal hollow chamfer
    - When preparing the buccal cusp, don't do a straight 90 degree cavosurface to the buccal axial wall
    - It is better to incorporate a concave margin at the buccal
    - Esthetics: blends tooth + ceramic colours, hiding the margin
    - Strength: gives porcelain more bulk in area of occlusion



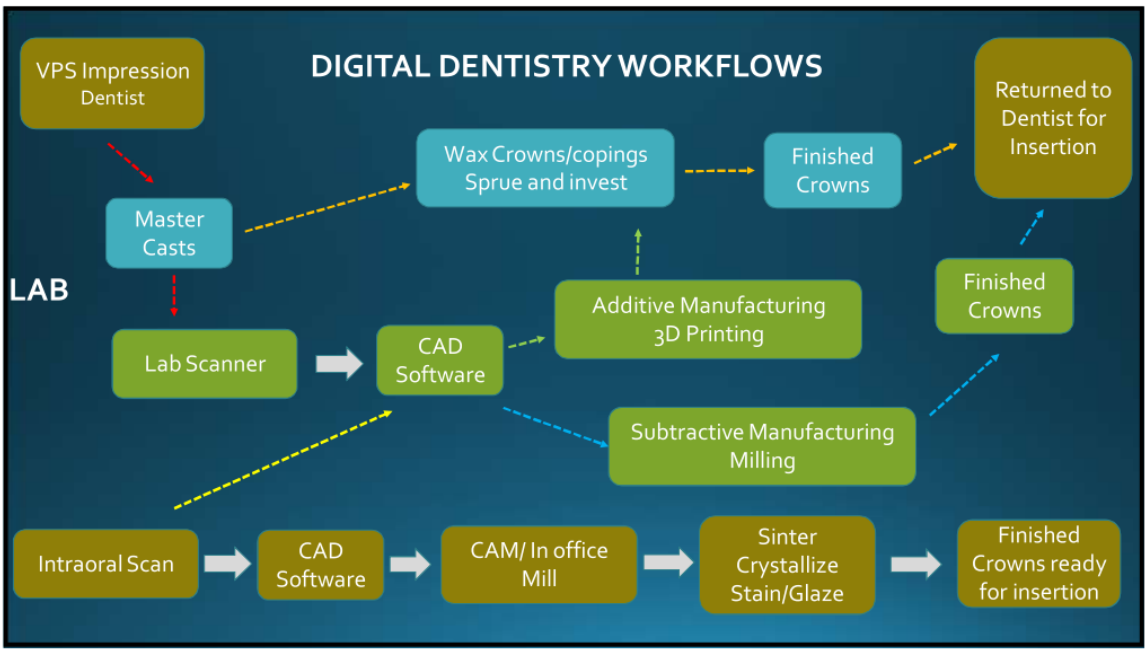
- How to use the CEREC system
  - Acquisition step
    - This is where you take the impression
    - Scan each arch, and then run the camera on the buccal from 7 to 3 for the bite registration
    - Scanner needs to be 0~15mm from the teeth
    - Pitch: tilting camera up/down
    - Roll: bucco-lingual rotation over the tooth
    - Yaw: aligning the camera with the curve of the arch
  - Biogenic reference
    - Machine uses another tooth in the arch, mirrors it, and uses that as the design
    - Commonly used for central incisors when one is broken
  - Model step
    - Orient the scan so that you can see the path of insertion
    - Orient the scan so that all the teeth are in the arch "outline" on the computer
  - Margination
    - Select margins on the prep

- Cleaning machine
  - Use CaviWipes, not Optim
  - Use PDI See Clear wipes on the camera
- Strength of CEREC restorations
  - MCC crowns are generally considered to be the strongest esthetic restorations
    - Most common failure is the ceramic chipping off the metal
    - Metallic coping remains intact, but the restoration is damaged
  - CEREC ceramics are higher quality than lab ceramics, with minimal/no flaws
    - Does not have a "weak link" like MCC. Success depends bonding of the ceramic to the tooth structure
    - Control over the firing temperature, powder particle size, etc → more control over properties
    - Flexural strengths: see tables →

Milling block	
Zirconia	1000
IPS e.max CAD	360
IPS Empress CAD	160
Vita Mark II	130

Laboratory	
Zirconia	1000
IPS e.max Press	400
IPS Empress 1	175
Feldspathic porcelain	90

- Digital dentistry workflow



- Trying in the milled crown
  - Remove the sprue and polish the crown
  - Afterwards, it's the same as any ceramic restoration: proximal contacts, margins, contours, shade and shape
  - Occlusion – should be done by the dentist manipulating the jaw, as the milled ceramic is not fired yet and is brittle
    - Don't tell patient to bite if the ceramic has not been fired yet
    - Emax compressive strength after milling = 130 MPa. After crystallization (baking) = 360~500 MPa
- Polishing
  - Should go from coarse to finer polishing bits
  - Different kits have varying polishing sequences – follow manufacturer instructions
- Stain and glazing
  - Glaze: colourless low fusing ceramic that has high fluidity at high temperatures. It fills in porosities and irregularities, leaving a glossy appearance
  - Stain: develops specific optical surface characteristics or colouring. Used to mimic translucency, hypocalcification, or occlusal staining
  - Should follow manufacturer instructions
  - Can create an optical illusion to make a monochromatic restoration look polychromatic
  - Preparing a crown for staining and glazing
    - Refine the crown shape and contour, so that it looks like a natural tooth
    - Use coarse rubber wheels to smooth the surface (smoother = higher value)
    - Clean the ceramic (steam cleaner, acetone, alcohol, hot water with soap and brush)
    - Dry the restoration

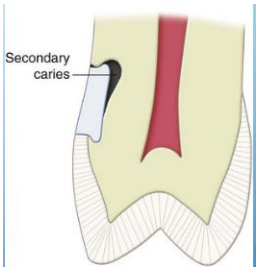
- Adhesive cementation
    - Relies on microretention rather than macroretention
        - Allows better conservation of dental structure
        - Success primarily depends on the luting agent, which must establish an effective, durable bond and marginal integrity
        - Luting agent properties: low solubility, high radiopacity, good esthetics, biocompatible, right working time
        - Longitudinal studies showed marginal degradation due to wear of resin cement
    - Polymerization types

Chemical cure	-Used in Maryland FPD's and posts	-Contains a peroxide which initiates the polymerization
Light cure	-Used in ceramic veneers	-Longer working time and better colour stability -Polymerization initiates from camphorquinone
Dual cure	-Used in inlay, onlay, and crowns	-Controlled working time, while polymerization still happens in areas not exposed to light -Contains peroxide and camphorquinone -Dual cure cements cured purely chemically were weaker than light cured

    - Ingredients
        - Matrix: Bis-GMA, UDMA, TEGDMA
        - Filler: inorganics (glass, quartz), radiopacifiers, pigments
        - Higher filler volume → less polymer shrinkage, thermal expansion, wear, increased modulus
- Ceramic surface treatment prior to cementing
    - Acid etching
        - Ceramics sensitive to acid etch: feldspathics, leucites, lithium disilicates (Vitablocks, IPS empress, Emax)
        - Ceramics resistant to acid etch: aluminum oxide, zirconium oxide (Procera, In-ceram)
        - HF acid dissolves glass matrix, leaving rough filler → high surface energy and micro retention potential
        - HF creates pores 0.5~12um deep
    - Silanating (SiH_4)
        - Promotes additional chemical bonding
        - Bifunctional: reacts with the inorganic OH group on ceramics and co-polymerizes with resin cement
    - Conventional ceramics have silica (SiO_2) and potash feldspar (K_2O, Al_2O_3, $6SiO_2$) and/or soda feldspar (Na_2O, Al_2O_3, $6SiO_2$)
    - Products like Monobond etch+prime have an etching component and priming component in one step
        - Safer than HF
- Firing
    - Fill the inside of the crown with fix putty, then adapt it to all the margins
    - Select the largest firing pin, and seat the crown + putty onto it
    - Place the restoration on the crystallization tray
    - Then, place in the Programat furnace
    - Firing is individually programmed so that it matches the material being used and purpose for firing
    - With Emax, we can crystallize first then stain + glaze, but we did the crystallize + stain + glaze all in one step

Cariology 1: recurrent caries

- Diagnosing caries needs a thorough
  - Caries risk assessment
  - Caries lesion detection
  - Caries lesion activity assessment
- Types of caries lesions
  - Primary caries: lesions on natural, intact tooth surfaces
  - Secondary/recurrent caries: lesion on a tooth surface adjacent to an existing restoration
  - Residual caries: demineralized tissue left behind before restoration placement



- Pathogenesis of recurrent caries
  - Same etiology as primary caries
  - Though it was due to residual caries, but this is only the case if the restoration did not seal the restoration margins
  - Restoration issues could include open margins, overhangs, open contacts, or defective restorations
- Caries associated with restorations and sealants detection criteria

Code 0	-Sound tooth surface with restoration or sealant	-No evidence of caries (enamel doesn't change after drying for 5 secs) -Marginal defects <0.5mm (probe doesn't fit) -Development defects, wear, or staining may be seen -May present with stained margins due to tea or coffee drinking
Code 1	-First visual change in enamel	-No evidence of color changes when wet, but opacity or discoloration seen when dried for 5 seconds 
Code 2	-Distinct visual change in enamel/dentin adjacent to restoration or sealant	-If retoration margin is placed on enamel, tooth must be viewed wet -Opacity or discoloration seen in enamel even when wet -If restoration margin is on dentin, there is discoloration not consistent with sound dentin or cementum 
Code 3	-Carious defects of <0.5mm with the signs of code 2	-Cavitation at the margin <0.5mm in addition to either: -An opacicty consistent with demineralization -A shadow of discoloured dentin 
Code 4	-Marginal caries in enamel, dentin, or cementum adjacent to restoration/sealant -Underlying dark shadow from dentin	-Tooth surface may have characteristics of code 2 -Also has a shadow of discoloured dentin under intact enamel OR with localized breakdown of enamel but no visible dentin -Shadow will look grey, blue, orange, or brown -Seen easier when tooth is wet -Lesion should be distinguished from amalgam shadows 
Code 5	-Distinct cavity adjacent to restoration or sealant	-As described in code 4, in addition to a >0.5mm visble gap or 0.5mm detecable gap with a probe 
Code 6	-Extensive distinct cavity with visible dentin	-Obvious loss of tooth structure -Extensive cavity clearly visible 

- Caries control and restorative care
    - Two main aspects to recalling patients for caries management
        - Monitoring lesions and checking their progression
        - Monitoring behaviour and oral hygiene (this is one with other health care providers)
        - These 2 aspects can be done in one appointment, but have to be reviewed separately
    - Recall intervals
        - Should be based on the age and risk status of the patient
        - As frequently as 3 months (<18 child with high risk) to once every 2 years (adult with low caries risk)
- Likelihood of new lesions or caries progression

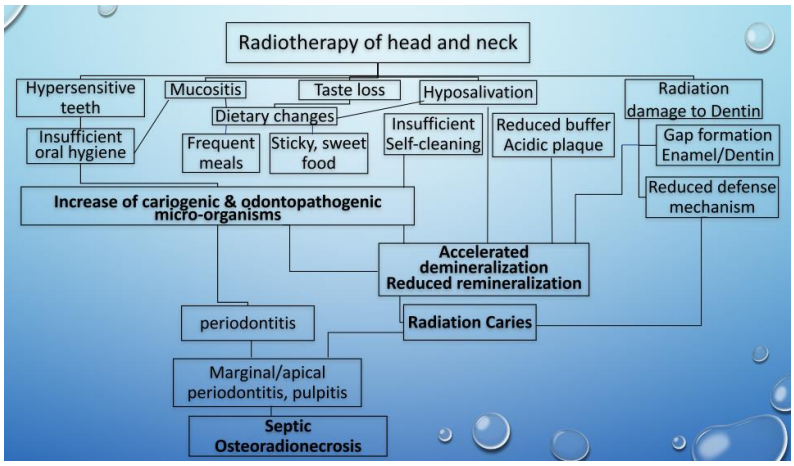
Caries risk status	Current caries activity		
	Inactive lesions	Initial stage active lesions	Moderate/extensive stage active lesions
Low risk	Low likelihood	Moderate likelihood	Moderate likelihood
High risk	Moderate likelihood	High likelihood	High likelihood

Cariology 2: rampant caries

- Multiple active caries occurring in the same patient
    - Rapidly burrowing type of caries resulting in early pulp involvement
    - Frequently involves surfaces of teeth not usually seen with caries
- Possible causes of rampant caries
    - Bottle or nursing caries, early childhood caries
    - Adolescent rampant caries due to poor habits (leaving sweets in mouth and going to sleep)
    - Radiation caries, secondary to salivary gland dysfunction from radiation damage
    - Drug induced caries
    - Chronic graft versus host related caries

- Nursing bottle syndrome, early childhood caries
    - Infants sleep with a bottle, containing milk or sugar
    - Liquid pools around maxillary anterior teeth and promoted acidogenic organisms
    - During sleep, there is less saliva flow, meaning teeth are less protected
    - Mandibular incisors are protected by the tongue, so they are usually unaffected
- Adolescent/adult rampant caries
    - New and growing challenge in conservative dentistry
    - Like ECC, the patient has a habit of falling asleep with carbohydrates in their mouth
- Management of rampant caries
    - RC is a sign of a severe dietary inadequacy, absence of oral hygiene, or systemic illness
        - Will need to do a comprehensive patient evaluation
        - Caries activity is more stimulated by the frequency, rather than the quantity of sucrose
    - Dietary counselling
        - Educate that frequent and excessive sucrose intake can cause caries
        - Reduce frequency and reduce consuming sucrose before bed
        - Chewing of sugar free gum after meals for 5~10 mins is recommended to high risk adolescents
    - Patient self care
        - High fluoridated toothpaste (5000 ppm) BID
        - Antimicrobials (0.12% CHX 15mLs rinsed 30s BID, preferably once before bedtime
            - The rinse before bedtime is good because the CHX lingers for a long time as there is not much saliva flow to wash it away
            - Rinse should be done >30 minutes after brushing teeth, as CHX should not mix with fluoride
            - 14 day of CHX suppresses strep mutans for 12~26 weeks (enough time for restorations)
        - MI paste applied on the teeth after brushing and left overnight
            - Milk based product with CPP-ACP. MI paste <u>plus</u> also contains 900 ppm fluoride
            - CPP-APP precipitates Ca and PO_4 onto exposed dentin surfaces

    - In office prevention
        - Fluoride varnish 5% (22000 ppm) in alcohol suspension at every visit, as frequently as possible
        - Tell patient not to ingest any of the fluoride
        - Dietary counselling and assessment of risk factors
- Methamphetamine use
    - Meth users have: poor dietary habits, poor oral hygiene, poor diet quality, and higher caries risk
    - Diet tends to be more sporadic (more snacking, and less meals) and sugar based
    - Meth causes hyposalivation and suppresses appetite
- Radiotherapy
    - Immediate effects of radiation: cellulitis, mucositis, dysphagia, weight loss, severe pain
    - Long term effects: rampant caries, trismus, xerostomia, osteoradionecrosis
    - Radiation caries can start within 3 months of the completion of radiation
    - Decreased saliva flow due to gland damage and high sugar consumption all contribute
    - Restorative treatment
        - Soft tissues become susceptible to trauma
        - Sharp and irregular teeth/restos should be smoothed down
        - Preferrable to restore teeth with a permanent material
        - Maximum mouth opening should be measured before radiotherapy, and this should be measured frequently to ensure it is maintained. Sometimes, growth of tumor can restrict this even before radiotherapy has started



    - Extraction selection and timing
        - Osteoradionecrosis is a risk once radiation has affected a dental area
        - Viable teeth should be retained. However, the less motivated the patient, the more aggressive one should be in extracting teeth prior to radiotherapy
        - Extraction criteria
            - Advanced caries lesions with questionable pulpal status
            - Extensive periapical lesions
            - Moderate or advanced periodontal disease (extensive attachment loss), especially with advanced bone loss, mobility, or furcations
            - Residual root tip, if not fully covered by bone or showing radiolucency
            - Impacted or incompletely erupted teeth
        - Extraction timing
            - Should be done as soon as possible, at least 3 weeks before radiation starts
            - Not always possible due to time constraints
            - If this is not possible, then the minimum is 10 days prior to radiation for maxillary teeth and 7 days prior to radiation for mandibular teeth
- Graft versus host disease
    - Complication of allogenic hematopoietic stem cell transplantation
    - Donated bone marrow cells make immune cells to attack the host
    - Onset is 70 days and continues for many years
    - Symptoms: mucositis, oral pain, hyposalivation, taste loss, oral infection, rampant caries
        - Saliva flow was seen to be reduced by 55~90%, with qualitative changes like lower buffering capacity
    - Affects mandibular anterior teeth, which is highly resistant to caries
    - Cervical areas of posterior and anterior teeth were most common sites
    - Incisal portions of anterior teeth were also affected

- Clinical oral dryness
    - Mirror sticks to buccal mucosa and tongue
    - Saliva appears frothy, doesn't pool on floor
    - Tongue has shortened papillae, lobulated, fissured
    - Debris on palate or sticking to teeth
    - Mucosa is glassy and gingiva is smooth

Cariology 3: esthetically challenging cases

- Silver diamine fluoride
    - Topical agent that has ammonia and silver fluoride. Arrests caries and helps with sensitivity
    - Mechanism
        - Ammonia stabilizes AgF by forming a complex $[Ag(NH_3)_2]^+$
        - When applied on the tooth, the AgF binds to protein layers, which increases resistance to acid dissolution and metabolism from bacteria
        - Bactericidal action on cariogenic bacteria, mainly strep mutans
        - Inhibited growth of cariogenic biofilms
        - Inhibited collagenases and protected dentin collagen from destruction
        - Lesions have increased mineral density and hardness and reduced mineral loss
        - Transmission electron microscopy confirmed that the precipitated solids were crystalline. The F anions substituted the hydroxyl anions on the hydroxyapatite crystals
    - How does this differ from fluoride varnish (NaF)?
        - NaF varnish replaces carboxy apatite with fluoro apatite
        - But with SDF, the phosphate component is also affected → leads to fluorohydroxyapatite
        - This further increases its acid resistance
    - Application regimen
        - Dose response relationship: better outcomes with more frequent applications
        - Combining synergistic effects of SDF and GIC is a good way to manage caries and have a reduced impact on esthetics
            - Multiple applications of SDF → lesion arrests → GIC
            - Single application of SDF → GIC
            - Secondary caries arise from the restorations → apply SDF in affected areas
        - If the patient is unlikely to return, then one application of SDF won't be very helpful
            - Instead, do a SDF application with GI on top
    - Adverse effects
        - Blackening of the lesion (happens over a week's time)
            - Very important to receive informed consent, with pictures of before/after so patient knows
        - Short term bitter, metallic taste
        - Temporary staining of soft tissues
        - Permanent staining of clinical surfaces and treatment trays
    - Case selection
        - Like stated above, maybe not the best for patients unlikely to come back
        - Symptomatic or partially necrotic pulps don't benefit from SDF

Cariology DALE 1

- Clenching and bruxism
    - Bruxism is associated with attrition of the teeth
        - Mild~moderate wear, mainly seen on canines and molars
        - Dentin wells (rim of enamel on the occlusal surface with a large dentin center
        - Will have muscle tenderness in the pterygoid
            - Can test this by placing your index finger in the patient's upper posterior vestibule and pushing outwards
            - Bruxing patients may jump as the medial pterygoid is so inflamed and tender
    - Clenching
        - Will see less wear on the canines
        - Will have muscle tenderness of the masseter
- Saliva flow
    - Can take measurements on stimulated and unstimulated salivary flow rates
    - You can't get an accurate unstimulated reading, as that only happens as soon as the patient wakes up
    - Stimulated flow rate is more reliable
    - Weigh how much saliva patient produces when chewing on a piece of paraffin wax
- Intraoral radiographs
    - New patient, no records: take a pan and PA's in areas of interest
    - Recalls: bitewings every 2 years, vertical BW's if there are >4mm pockets
    - When patient complains of pain/sensitivity in an area
    - Clinical sign of caries, large restorations, trauma, during RCT
    - It is possible to see a radiolucency on radiographs but no evidence of caries clinically
- Clinical examination for caries
    - Waxed floss through interproximals to feel for catching
    - Nabers probe to feel for catching
    - Transillumination
- Supraeruptions
    - Happens when there is tooth loss, and the opposing tooth is not in occlusion
    - More disruptive than M/D tilting
    - Can cause "eccentric interference," as the occlusal surface causes lateral or protrusive interferences
- Occlusal trauma
    - Thickening of PDL, laddering of trabeculation, widening of PDL space
    - Occlusal forces cause bone to align perpendicularly to the long axis of the tooth
    - In the maxilla, the laddering will be horizontal. In the mandible, it will be on an angle

Cariology DALE 2

- Microscopic examination of a non cavitated carious lesion
    - Zone of demineralization
        - Right below the enamel lesion
    - Translucent zone
        - Some demineralization and sclerosis of the dentin tubules
    - Reparative dentin
        - In the pulp chamber, there is tertiary dentin being deposited
    - The zone of bacterial invasion is missing
- Missing teeth
    - Anodontia – no teeth
    - Hypodontia – missing 1~5 teeth
    - Oligodontia – missing 6+ teeth, not common, hereditary, and sometimes associated with syndromes
    - Do not count wisdom teeth when classifying

- Crown materials
    - Gold
        - Good for bruxing patients
        - Allows for minimal reduction and minimal wear on opposing teeth
    - Gold-MCC
        - Can be done, but if the patient wants the yellow luster in the gold, the alloy has to be high noble
        - Noble gold-MCC is not possible, needs to be high noble-MCC
    - Base metal-MCC
        - Avoid, as it has shrinkage and does not fit like a noble or high noble
        - Inferior properties as well
    - MCC
        - Used in the anterior region, where patients have a really deep overbite
            - The metal part on the lingual allows minimal reduction
            - Preserves as much tooth structure as possible, as these teeth will need it
            - Depending on patient's protrusive movement, the metal can be just on the lingual, or it may need a facial wraparound
            - Occlusal contact should not be at the ceramic-metal interface
        - Used on teeth with enough structure to support the margin
        - Starting from the coping, porcelain is layered on and fired over and over by hand
    - Emax layered porcelain
        - Avoid in posterior teeth on a bruxing patient, will fracture

Cariology DALE 3

- Non carious lesions involving tooth loss
    - Cervical lesions: abfraction, abrasion, erosion
        - Abrasion
            - Most commonly seen when brushing too hard or using abrasive toothpastes like sodium bicarbonate
            - Left canines usually have the most abrasion for right handed patients
            - Other sources: lip rings and tongue rings that rub at the teeth
        - Abfraction
            - Wedge shaped, concave lesion
            - Thought to happen due to tooth flexure under occlusal load
            - Layers of the tooth are lost due to cyclic loading, flexing, and shearing
            - Not painful if it happens slowly, as the pulp compensates by depositing dentin
        - Erosion
            - Surface layer or enamel is dissolved away by the acid
                - Differs from caries, as caries leaves the surface intact and undermines the enamel and dentin, until it cavitates
            - If due to vomiting, the maxillary anteriors are affected the most
            - If due to eating lemons or drinking lemon water, tell them to stop
    - Non cervical lesion: attrition
        - Happens on occlusal surface
        - Wear due to long term function of teeth
        - Malocclusion, parafunction, clenching can accelerate this process
        - If coupled with erosion, attrition can also be accelerated
- Management of non carious lesions
    - Restoration
        - Restoring it will not always fix it. The restoration will likely just pop out
        - Composite or GI can be used, depending on isolation
        - Desensitizing agents can be applied (GLUMA tubule occluder, ICON fissure sealant for smooth surfaces)
    - Sensodyne

Single tooth implants

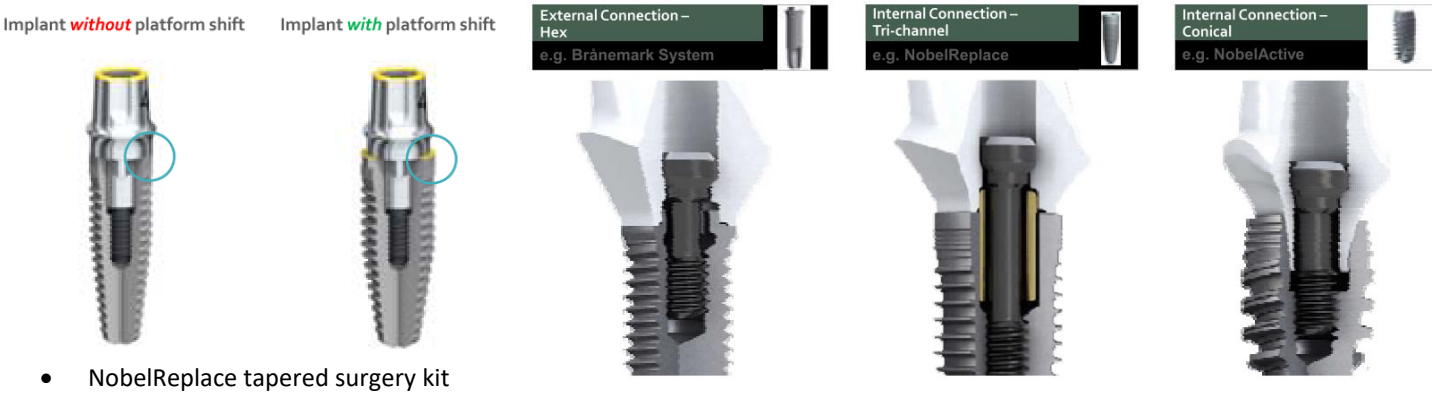
- Rationale for dental implants
    - Preservation of sound tooth structure
        - Patients may request cutting into 2 healthy teeth, to replace 1 missing tooth
        - This is very bad
    - Preservation of alveolar bone
        - Bone needs to be in function to prevent resorption of hard tissues
    - Provision of additional support
        - Makes mastication more efficient, gives improved support and stability in PRDP's and CRDP's, and decreases load to the remaining dentition
    - Resistance to disease
        - Bridge survival: 87% at 10 years, 69% at 15 years
            - Teeth are prone to dental caries and periodontal disease
            - Patients that are special needs, have xerostomia, or are high risk may have worse prognosis
        - Implants are not prone to caries and tend to hold up better than FPD's
            - However, they are still prone to bone loss, tissue inflammation, and peri-implantitis
- Record taking
    - Referral source
    - Patient interview
        - Chief complaint
        - Dental history: reason for tooth loss, previous treatments, diet, OH, oral habits/parafunction
        - Medical history
        - Previous implant experience
        - Patient expectations
            - Large bone defects are difficult to treat with a good outcome
            - Orthodontics may be needed to orient roots or teeth properly, so that an implant can fit
        - Risk/benefit analysis, with other treatment options
        - Patient understanding costs of long term care
        - Make sure patients know implants will not likely last forever. Many patients expect them to last for life
    - Dental exam
        - Adjacent teeth: structural integrity, periodontal condition, endo status, prognosis
        - Edentulous space: residual ridge anatomy, bone and soft tissue profiles
        - Esthetics: anterior or posterior, high or low smile line
    - Radiographs
        - Periapicals
            - Simplest radiograph
            - Allows us to see alveolar profile, endo status, and grafting potential
        - Panoramic
            - Good for overall screening
        - Computed tomography
            - For full assessment of implant positioning
    - Photographs
        - Extraoral profile and lip support
        - Smile
        - Intraorals
    - Study casts
        - Allows operator to measure M-D, B-L and interocclusal distances
        - Allows operator to make a diagnostic wax-up and get esthetic approval prior to surgery
        - Allows fabrication of radiographic and surgical guides
        - Can select abutments, make provisional templates, and make custom acrylic trays

- Implant requirements
    - There has to be enough bone
    - Patient's VDO is established and not expected to change
- Guided surgery
    - Good for an aid, but doesn't make up for lack of experience
    - Helps be more precise, preserve anatomic structures, shorten treatment, less invasive (flapless surgery is possible)
    - Costs $500-1000 to make, and it's on the operater to pay for another if it doesn't fit
- Evaluation of the edentulous space
    - Residual ridge resorption compared to contralateral tooth
    - Soft tissue dimensions
        - Vertical space needs to be at least 7mm
        - Buccolingual thickness needs to be at least 6mm
        - Space between mesial and distal roots needs to be 7mm (4mm implant + 1mm bone on each side + 0.5mm PDL on each side)
    - Mucosal thickness (gingival biotype)
        - Will influence which abutment we pick
        - Thinner biotypes will have issues with esthetics due to recession
        - Must consider accessibility to oral hygiene
    - Are the adjacent teeth tipped, rotated, or malpositioned?
    - Distal free end spaces usually have narrow spaces – tell patient implant crown will be short
    - Note the adjacent papilla and frenal attachments

- Preparation of the edentulous site
    - Bone graft: autogenous, allograft, xenograft
    - Soft tissue: reduction, augmentation, papillary reconstruction
- Esthetics
    - Implant crown: position, tooth size, shape, contours, colour, material
    - Gums: papillary architecture
    - Implant crowns can also be retained by a screw or cemented onto the implant fixture
    - Cemented implants
        - Cannot be retrieved or removed in the future without breakage
        - Cement extrudes into the sulcus and compromises the tissue cuff around the implant
        - Could even cause a bone crater
        - However, allows custom abutments
    - Screw retained implants allow retrievability, and possibility to add units in the future
    - Provisional implant crowns (acrylic or composite) can be given to the patient
        - Reasons: esthetics, expected changes in dentition, needing future crown lengthening or ortho
        - Provisionals can be left on for years
        - Can try out different shapes and optimize to minimize tissue blanching and black triangles
        - Definitive restoration is only placed when the dentition is stable
- Difficult occlusions
    - Canines
    - Class II div 2
    - Class III
    - Edge to edge occlusions
    - Attrition, pathological wear, limited restorative space
- Splinted implants
    - Allows better load distribution
    - Hygiene is more difficult as patients cannot floss
- Anterior cases
    - Custom abutments are preferred, due to the steep angle of anterior teeth
    - Zirconia abutments could also be used, so that the metal doesn't show through

Nobel implant surgery sim experience

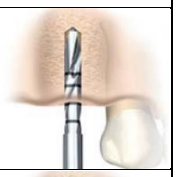
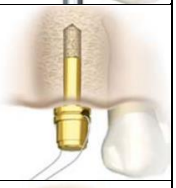
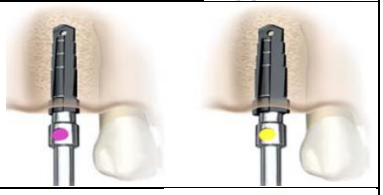
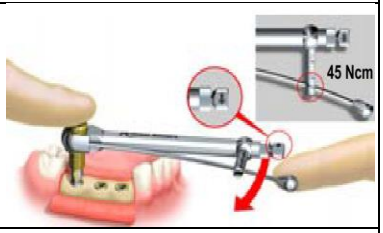
- Implants need to be prosthetically driven
  - Always make things more predictable for the prosthetics that are planned
  - For example, try to avoid off-angle implants
  - Conventionally, we would wax up the restoration and then decide the proper angulation of the implant
  - Nowadays, this is done digitally
- Implant dimensions
  - Tapers: implants can be tapered (NobelReplace CC) or parallel (NobelActive, Parallel CC)
    - There are different drilling protocols for these 2 shapes of implants, DON'T mix them up
  - Length: comes in 8mm, 10mm, 11.5mm, 13mm, 16mm
  - Diameters: 3.5mm, 4.3mm, 5.0mm
  - Platforms (implant-abutment interface): narrow (purple, for the 3.5mm diameter implants) or normal (yellow, for the 4.3mm and 5.0mm diameter implants), or wide (blue)
  - Platform shift: platform shift implants have the abutment slightly narrower than the platform, whereas non-platform shift implants have the abutment the same diameter as the platform
  - Implant connections: implants may have an external connection (like a hex screw), or an internal connection (3 circles in a triangle formation, or one large cone)



- NobelReplace tapered surgery kit
  - Follows the universal colouring scheme (purple = narrow, yellow = normal, blue = wide)
  - A drill protocol is provided for reference
  - The whole kit is autoclavable
  - Drills go 1mm deeper than implants. If the implant says 15mm, the drill kit will drill down to 15mm, but the actual implant is 14mm

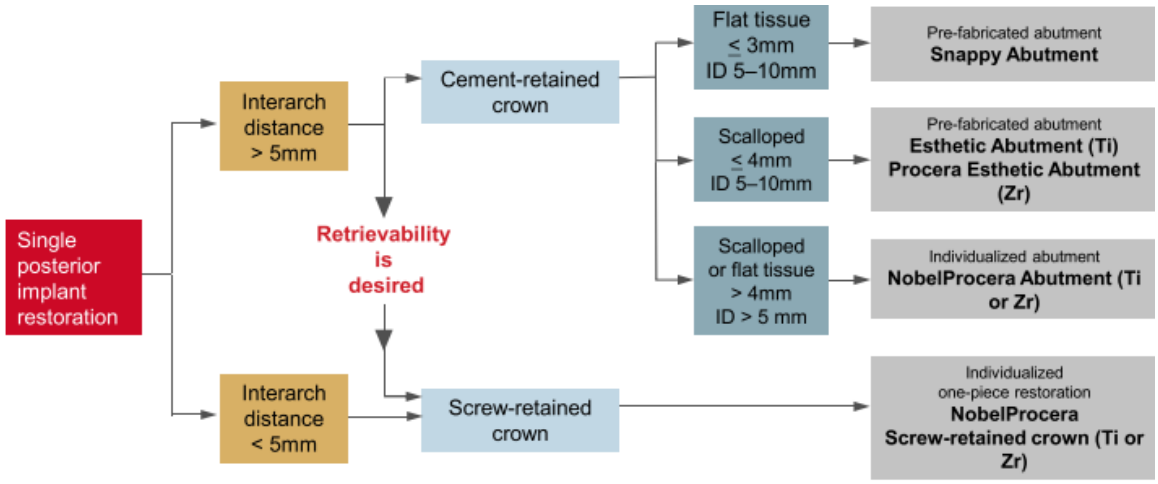
- Implant packaging
  - Implants are packaged in a container
  - The container has 2 peel off labels
  - The labels can be attached to patient charts
- Drilling considerations
  - Internal and external irrigation is used during drilling
  - Keep drills in motion while in bone
  - Drill for 2 seconds, withdraw completely, then reinsert
    - Keeps drill cool
    - Flushes bone chips
    - Maintains drilling efficiency
  - Drill constantly rotating
- Rheostat
  - Has a water pump switch, program switch, forward/reverse switch, and speed control

- Steps to implant surgery

1	-Guide drill (optional)	-Can place a dimple in the bone to mark the drilling point
2	-Initial osteotomy	-Use the 2mm drill at 800 rpm max -Drill to desired depth (drill is notched at desired depth for reference) 
3	-Direction indicator	-Checks the osteotomy direction and location -Inspect relationship with adjacent teeth 
4	-Enlarging osteotomy	-Drill with drill tapered NP 3.5mm (purple) at 800 rpm max -Drill to depth, but stop short if unsure how deep you need to go -If necessary, widen the drill prep with the RP 4.3mm (yellow) -If necessary, widen the drill prep again with the RP 5.0mm (blue) 
5	-Position locator	-Evaluates the final implant seating depth and trajectory -Just flip the direction indicator upside down -The black part of the drill must fully sink into the bone, otherwise the implant (grey) will not fully seat 
6	-Dense bone protocol	-When you encounter type 4 (dense) bone, there are 2 extra drills **Dense bone drill (left)** -Select the drill that matches the implant (purple, yellow, etc) -Drill one pass into the prepared site -Maximum speed 800rpm **Tapered screw tap (right)** -Select the matching screw tap -Apply it at low speed, applying firm pressure -When the threads engage, allow the tap to feed without pressure -Proceed to the marking -Maximum torque is 25 Ncm 
7	-Implant placement	-Implant is housed in a sterile crucible -Attach the implant driver to your handpiece -The implant can be picked up straight from the crucible, which avoids any possible contamination -The implant driver is fully attached to the implant when the black surface on the driver is fully hidden -Don't use water during implant placement -The connection inside the implant is a hexagon. You want one of the flat sides of the hexagon to be parallel to the buccal wall 
8	-Manual torque wrenching	-Used for final positioning and final depth -Need 35~45 Ncm of torque for immediate loading -Never use the stiff arm to tighten the implant, as it can easily reach 200~300 Ncm without effort -Always push on the flexible thin arm 
9	-Final-ization	-<u>One stage immediate:</u> make a provisional and send patient home -<u>One stage delayed:</u> attach a healing abutment and suture soft tissue if applicable -<u>Two stage delayed:</u> attach a cover screw → suture closed → send patient home -Picking the correct healing abutment: height should be equigingival or slightly thicker

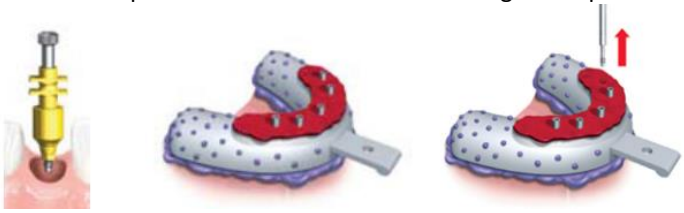
Screw retained implants

- Implant crowns can be cement retained or screw retained



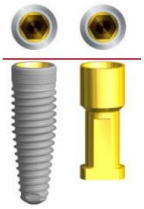
- This lecture focuses on screw retained
- Screw retained implants
    - Advantages
        - Good for: low cost, limited arch space, limited M-D width, retrievability
        - No concern with cement removal, does not show a margin if there is tissue recession
        - It is possible to place screws on an angle (via angled caps), which is good for limited opening, or moving the access out of an area of occlusion
        - Angling the screw is also used in anterior implants. The implant is moved more buccally so that the lingual anatomy is not overcontoured
        - Better than cement retained for bruxing patients
    - Disadvantages
        - Ideal axial positioning is required, extensive planning is involved
        - Access hole with composite may be visible
        - Porcelain may chip at rim of access hole

- Open tray impression technique
    - Attach the impression coping to the implant
        - This impression coping has fins, so they mechanically lock in to the PVS
        - Take a radiograph to make sure it is seated properly and fuly
        - Tissue may blanche while tightening. Wait for it to return to normal, then continue tightening
    - Perforate the impression tray, so that the impression coping will fit through
    - Inject impression material around the copings and fill the tray
    - Take the impression
    - Ensure tips of all guide pins are visible (can block out with wax)
    - Remove guide pin so that the impression coping can be removed with the impression
    - Screw implant replica to impression coping
    - Send impression to lab
    - Cast will be returned with a thin layer of silicone around the implant → this is called the tissue mass, and is used to replicate the soft tissue when making the implant crown

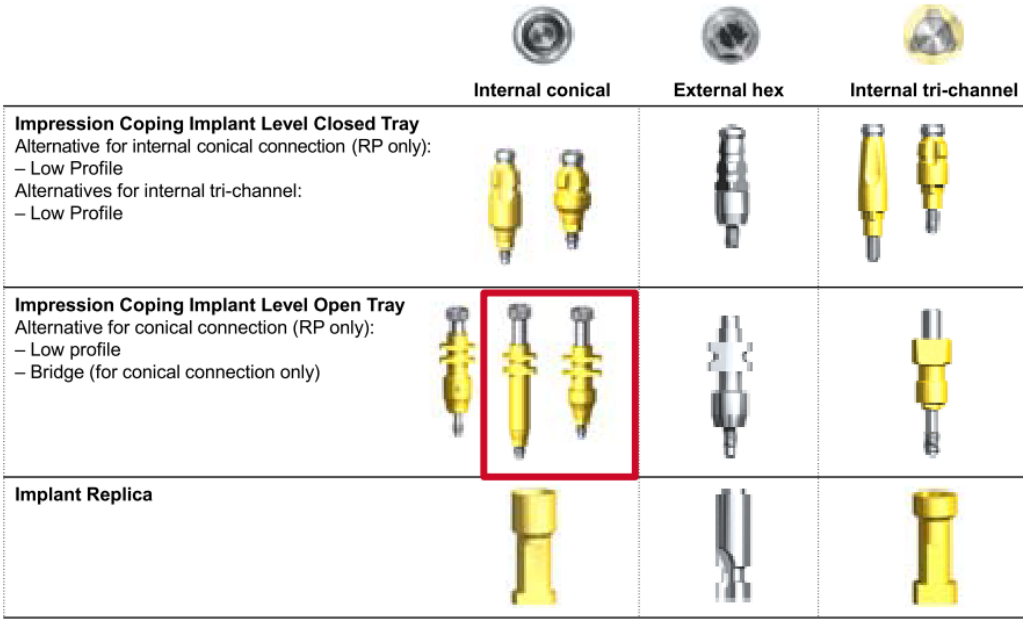


- Closed tray impression technique
    - Attach the impression coping to the implant and take a radiograph as stated above
    - Inject impression material around the impression coping and fill the tray
    - Block out the hole on the guide pin
    - Since we can't unscrew, just pull the impression off. Then, unscrew guide pin and insert coping into impression

- Pouring up implant impressions
    - The lab, or the dentist will attach an implant replica to the impression coping on the impression
    - The impression replica mimics the implant that's in the patient

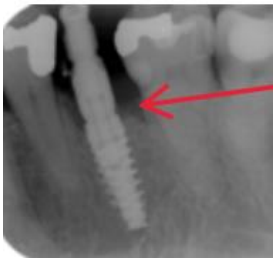


- There are many types of implant copings
    - This chart only shows the normal sized (yellow 4.3mm and 5.0mm) copings. There is also another set for small (purple 3.5mm) copings

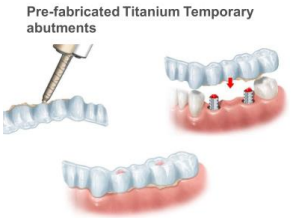


	Internal conical	External hex	Internal tri-channel
Impression Coping Implant Level Closed Tray Alternative for internal conical connection (RP only): – Low Profile Alternatives for internal tri-channel: – Low Profile			
Impression Coping Implant Level Open Tray Alternative for conical connection (RP only): – Low profile – Bridge (for conical connection only)			
Implant Replica			

- It is critical that the implant coping is fully screwed into the implant
    - This is why we take a radiograph
    - Any deviation from proper seating will affect the implant crown in the end
    - The radiograph must be clear enough to see the threads on the implant and there should be a very small indent, indicating the junction between the implant and coping
    - Impression coping should be placed immediately after removing the healing abutment, so that the tissue does not collapse
    - Reconnect healing abutments immediately after removing the impression coping



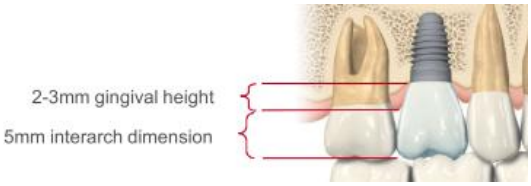
- Temporization
    - Screw on prefabricated titanium abutments
    - Block out screw holes with wax
    - Use integrity and a vacuform to make provisional



Cement retained implants

- The crown is cemented on to an abutment of the implant
    - The abutment needs to have the ideal height and margin
    - Retraction cord can be placed around an abutment for a better impression
    - Abutment is left in place, with a provisional restoration on top
    - The abutment essentially acts like a crown prep

- Which type of abutment do we select?
    - Considerations: distance from implant platform to bone crest, interocclusal distance, thickness of gingiva, biotype, emergence profile, shape and contour of tissue
    - Ideally, gingiva will be 1~3mm and flat shaped. The interarch should have 5~10mm of space
    - Anything less than 5mm of interarch space will have to be screw retained (see flow chart above)



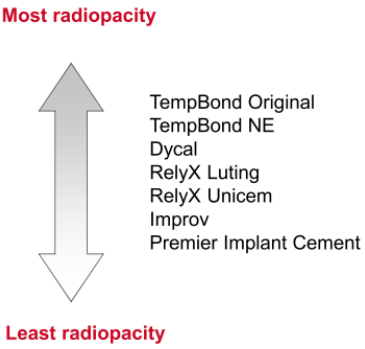
- Abutment selection

Snappy	Esthetic	Individualized
-Prefabricated -Titanium -Straight	-Pre-fabricated, but customizable -Titanium -Varying margins, angulations, contours	-NobelProcera: makes titanium or zirconia abutments -GoldAdapt: makes gold abutments
-For gingival height 1~3mm -Interarch distance 5~10mm -Flat tissue architecture	-Correcting minor angulation problems -For scalloped margins with gingival height <4mm	-Scalloped margins -Thick soft tissue -Angled implant -Excessive interarch or interproximal

- Limitations
    - Crown margins cannot follow varying gingival topography, as they are pre-fabricated
    - Cement margins need to be accessible
    - Cement removal may be difficult
    - Adequate interarch space needed for porcelain
    - Adequate interproximal space needed for abutment and crown
    - Margins and abutment may show if there is tissue recession
    - Removal of crown may require cutting of crown

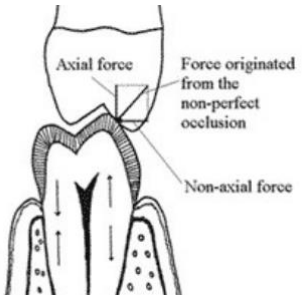
- Prefabricated abutments (Snappy, esthetic)
  - Impression
    - On the implant → pre-fab abutment screwed in → snappy impression coping seated
    - Take the impression
    - Impression coping (yellow) will come off with the PVS impression
    - Attach an implant replica to the impression's coping
    - Apart from the abutment, this is essentially the closed tray technique
  - Temporization
    - Keep the pre-fab abutment in the patient
    - Insert the snappy abutment healing cap or pre-fab temporary coping for esthetic abutments
    - A vacuform + integrity provisional can be made on this now

- Individualized abutments
  - Can be used, and allows better gingival topography
  - Wasn't specified how we take impressions on these
- Tightening abutments
  - Once the abutment has been verified to be fully seated by a radiograph, it may be tightened
  - Tighten the abutment to 35 Ncm using the same manual torque wrench used to screw the implant
- Cementing the crown
  - Place retraction cord in the sulcus
  - Clean, dry, and isolate the abutment and close the screw head with a removable material like a cotton pellet
  - Mix cement and apply inside the crown
  - Seat the crown using finger pressure
  - Remove retraction cord and excess material
  - Check occlusion
- Cement and peri-implantitis
  - Excess dental cement was associated with peri implant disease in 81% of cases
  - Some cements have poor radiodensity and may not be detectable on radiographic exam
  - After 6 and 12 months post loading, cement retained crowns had a consistently higher degree of sulcus bleeding and plaque accumulation compared to screw retained crowns



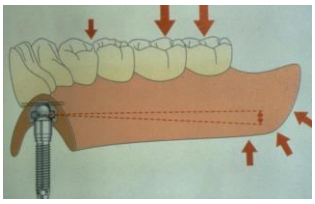
Occlusion and biomechanics of implants

- Forces acting during a malocclusion
  - The resulting bite for is perpendicular to the plane of contact
  - If the oblique force is too strong, it may break the restoration or cause bone loss
  - This is bad in implants, because the force is directed to a concentrated area on the bone crest
    - Implants are best in axial loading, where the force can be distributed throughout the entire implant
  - Steeper the cusps = stronger the off-axis force
    - Therefore, it is recommended to create shallow or flat occlusion lines to minimize overloading
- Uneven loading
  - If you make an implant crown the same height as a tooth, the implant will take the most force
  - This is because teeth are surrounded by compressible PDL, whereas implants are fixed in place
- Consequences of implant overloading
  - Dislodged restorations, screw loosening, screw fracturing
  - Peri-implantitis, crestal bone loss
  - Implant failure

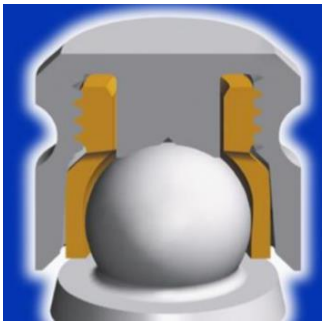


Implant overdentures

- Benefits of implant dentures
  - Patient mediated acceptance
  - Stable and retention of prosthesis
  - Retardation of residual ridge resorption
  - Minimal risk of morbidity
- Potential systemic health factors that may affect treatment
  - Diabetes mellitus
  - Osteoporosis
  - Bisphosphonate therapy
  - Irradiation therapy



- Implant overdenture principles
  - The implant is fixed, but the attachment to the denture should allow some rotation
    - The implants are clipped on the anterior region
    - The posterior region is soft tissue supported, so has some movement
- Edentulous mandible treatment
  - Treated with 1~5 implants supporting a removable or fixed prosthesis
    - Multiple implants could also be splinted by a bar, which provides extra stress distribution, if the bar is connected to the implants passively
    - The longer the bar = more clips = more stability and reduced clip wear
  - Patient selection
    - Denture assessment
      - Current denture should be acceptable appearance, acceptable design, and stable
      - Unstable dentures should be replaced by a new one, rather than fixing the old one
      - Prosthetic space over implant must be ≥5mm
      - If there is inadequate space, then an alveoloplasty can be done
    - Ridge assessment
      - Bone height and width ≥10mm and 6mm width
  - Surgical complications
    - Pain, bleeding, infection
    - Sensory disturbance
    - Implant failure
    - Jaw fracture
  - Implant placement
    - The mandible inherently has some flexibility at the symphysis. If implants are placed from 7 to 7, it makes the mandible rigid. This can cause many problems like pain
    - Anterior teeth are usually the last teeth to be lost, so it has the best bone. Implants in the posterior are not very common, as there is usually severe bone loss
  - Treatment sequence
    - Make sure the patient brings their previous non-implant dentures
    - Stage I: Place the implants → relieve the denture → soft reline (14 days max) → give denture back
    - Stage II: Reveal implant → place healing abutment → re-approximate tissues → reline again
- Fixed dental prosthesis
  - Possible materials
    - Hybrid: metal + acrylic + composite
    - Metal ceramic
    - Zirconia ceramic
  - Has better patient satisfaction, but has its own complications (hygiene, fracture, repair)
  - Acrylic will wear faster than when used in conventional dentures



- Abutment selection
    - 2.25mm ball abutments are attached to the implants
    - The heights can vary from 1, 2, or 3mm
    - In the denture, there is a gold cap-ball attachment which articulates with the ball
    - Delivering to the patient
        - Remove healing abutment
        - Seat the ball abutment with 15 Ncm torque
        - Ball abutment should be 2~3mm above gingiva
        - Assess radiographically
    - Other abutments: locators, implant bar + clips

- Implant denture fabrication
    - Once ball abutments are placed, take an impression with PVS and custom tray
    - Insert the replica ball abutment into the impression
    - Pour up stone to get master cast with the ball abutments also in place
    - Use cast to make a record base and wax occlusion rim
    - Rest of the denture steps are like normal dentures (set-up, JRR, try-in, insertion, maintenance)
    - If implants are at different heights, then you can choose different abutments so they are occlusally at the same level
- Denture maintenance
    - Only remove fixed dentures when there is a need to do so
    - Examples: peri-implantitis, fracture of teeth, recontouring intaglio surface for better hygiene

Implant papers (thank BIDDLE GOD)

- Treatment planning for dental implants

Systemic host factors	Age	-Quality of bone is more important than age **Growing age** -Implants can submerge, lose support, relocate, interfere with growth, change occlusion -Men stop growing at 18, women stop growing at 15. However, better to make sure with a serial ceph **Old age** -Longer healing times, more systemic health factors, decreased ability to maintain hygiene, issues adapting to new prosthesis
	Gender	-Not a factor
	Diabetes	-Issues with healing, inflammation, bone metabolism -Implants are successful if diabetes is well controlled
	Osteoporosis and estrogen status	-Osteoporosis is not a contraindication for implant treatment, nor does it cause implant failure -No link between post menopausal age and implant failure -Maxillary implants are more at risk, as osteoporosis affects trabecular bone more -Be cautious when doing maxillary implants in pts with severe osteoporosis
	Cancer therapy	**Radiation** -History of radiation therapy has a reduced success (70%), but it is no longer a contraindication -Should wait 12 months after radiation to place implants, but hyperbaric oxygen treatment may speed up this waiting time -Avoid soft tissue supported prostheses as tissue healing can be poor **Chemotherapy** -Not a significant determinant to success
	Corticosteroids	-Long term CCS use causes reduced bone mass, delayed wound healing, and suppresses immune system -However, it is not a contraindication to implants
	Genetic, immune system	-Needs more research
	Other diseases	-Not important -Local bone quality and patient's long term survival is more important
	Cluster phenomenon	-Not one single factor is a contraindication, but a cluster of factors could be -However, local bone quality is a greater predictor of success

Drugs	Antibiotic premedication	-Systemic abx use before surgery may reduce chances of infection and increase chances of osseointegration -Abx is more likely to be suggested in immunocompromised, or those who need long surgery -Smokers have increased success when abx are used
	NSAIDs	-Slows rate of alveolar bone loss, but not established in literature yet
Habits	Smoking	-Recommended to stop smoking at least 1 week before and 8 weeks after implant surgery **First stage implant surgery** -Smoking does not affect this stage much, as osseointegration is happening away from the smoke -Implant site is closed off from the smoking environment **Second stage implant surgery** -This is when soft tissues are exposed and left to heal, which smoking does affect negatively -Smoking causes increased: peri-implantitis, increased bone resorption -Affects maxillary implants more than mandibular -Heavy smokers tend to have poorer quality bone
	Parafunction	-Increased pressure on implants can cause fatigue, fracture, and bone loss -Overloading is the primary cause of late stage implant failures -Strategies -Treatment modification: use acrylic teeth, add more implants, plan placement to ↓ overload -Pay close attention to occlusal contact design -Bruxism appliance -Patient education
	Oral burn syndrome	-Deleterious effect to soft tissues around implants after ingestion of hot foods or liquids -Not really well researched
	Addiction	-Generally have poor oral hygiene, so unlikely they will take good care of implants -However, addiction has not been proven to alter implant success
Local factors	Hard tissue	-Bone quantity: more bone-implant surface area -Bone quality: larger, denser bone mass that are able to resist forces **Bone requirements** -1.5mm of bone on buccal and lingual of implant -3mm of bone between implant and adjacent tooth (1.5mm on each side) -Good mix of cortical (early stability) and trabecular bone (bone with good blood supply) **Bone height** -Too low: will need grafting to augment the bone -Too high: may result in an implant that causes occlusal interferences. Could also affect masticatory function, phonetics, and esthetics as a result
	Soft tissue	-Attached gingiva: presence/absence does not affect long term soft tissue health, bone loss, or implant survival rates -KT/alveolar epithelium: KT has less recession and inflammation. Alveolar mucosa directly around implants can cause severe resorption if mobile due to muscle attachments
	Infection	**Peri-implantitis** -Caused by same as perio bacteria (gram neg anaerobic rods and spirochetes) -Progressive bone loss, possibly to loss of implant -Implants with a rough surface have more bacterial growth -Important to maintain optimal oral hygiene. CHX 0.12% can be done as well **Endo treated teeth** -Having an endo treated tooth next to an implant may be harmful
	Occlusion	-Avoid lateral excursive contacts -Avoid off-axis loading in centric occlusion

- Prosthesis design factors

Number and size of implants	-Greater number, larger size = more surface area for integration = better chance for stability -However, anatomical restrictions and bone dimensions are the major limiting factor -4mm diameter implants survive better than 3mm
Spacing of implants	-Need 3mm of bone between an implant and the adjacent tooth or adjacent implant -Note: I thought we were taught 1.5mm, not 3mm?
Cantilevers	-If the antero-posterior spread of abutments is >11.1mm, then a cantilever can be used -If this AP spread cannot be achieved, then an overdenture or bar-clip denture should be used -Cantilever is less predictable for maxillary arch, so it's suggested to use implant retained overdentures
Cement vs screw retained	-Cement retained -No screw to affect esthetics and occlusion -Less # of components needed, reduced cost -More passive fit -Very similar to cementing a conventional crown -Minimizing screw loosening -Occlusal force and centric relation along long axis -Minimize cantilever length -Posterior working and non working contacts eliminated -Anterior guidance shared with natural teeth
Restoration material	-Metal and ceramics
Passivity of fit	-Misfit implants could put strain on implant-bone interface, leading to failure -Not much research on long term effects of misfit
Implant-tooth restoration	-These combination restorations should be avoided -Causes intrusion of teeth
Implant surface	-Theoretically, a cast restoration next to an amalgam could cause corrosion -In practice, having a noble alloy shows little susceptibility to corrosion

- Mandibular implant overdentures

About	->50% of conventional dentures have issues with stability and retention -Can be fully supported by implants, or partially supported by an implant -Significant improvement in retention and stability with relatively cheaper costs and simplicity compared to fixed
Implant vs teeth abutments	-Implants have a higher success rate -Cost effectiveness of implant + overdenture is more favourable than tooth + overdenture
Preservation of bone	-Resorption is 4x faster in the mandible as opposed to the maxilla -Significant effects of maintaining alveolar bone after the first year
Number of implants	-Options: rigid bar or independent implants -A mandibular overdenture should have a minimum of 2 implants -2 implants used → independent implant system is used -2+ implants used → a bar system is often used -Major determinant of success is patient's perceived denture stability
Combination syndrome and implants	-Mandibular implant overdenture opposing maxillary complete dentures may cause combination syndrome due to the forces loaded on the anterior maxilla -Maxillary bone resorption, soft tissue inflammation may result -Can be avoided by ensuring a stable occlusion and force distribution
Peri-implant response	-Favourable peri-implant response
Complications	-Most common: screw loosening, replacing attachment clips, peri-implantitis -Others: gingival hyperplasia, maxillary relines, occlusal adjustments -Most repairs are needed after the first year
Patient satisfaction	-Most are satisfied compared to not having implants -Most want implants so they can improve their eating ability, which is usually accomplished -Success is usually excellent
Controversy	-Complicated restoration of mand. anteriors vs extractions + implant overdenture -# of implants, using a bar, combination syndrome, KT vs alveolar mucosa are all debated

- Screw retained vs cemented implant restorations

Esthetics	-Going against screw retained just due to esthetics is not valid -Screw retained can be esthetic if the implant access can be in a non esthetic area, like the lingual surface
Retrievability	-Screw is much better for retrievability, but it is possible with cement (just less predictable)
Retention	-Screw retained gives retention in limited interarch spaces -Cement retained follows conventional fixed prosthodontic principles
Implant placement	-Implants meant to hold screw retained restorations are more dependent on orientation -Requires good planning, preparation, surgical guides
Passivity	-When an implant is not under load, there should be no stresses applied on the bone-implant interface -Passively fitting ("relaxed") implants are ideal, but studies show it is impossible to achieve -Cement retained implants are generally more passive, however -Research can't seem to demonstrate a significant difference in real life though
Provisionals	-Screw retained provisional restorations are the simplest -Healing caps don't have proper contours and look smaller than an actual tooth -Initial provisionals will blanch the tissue, but will resolve quickly. Takes about 6 weeks for the provisional to form the soft tissue into desired contours
Occlusion	-Screw retained has no instability or unwanted wear if the contacts are on the restoration, not the access hole -Screw access hole should play no part in occlusion
Immediately loading implants	-Cement retained introduces cement to tissues, which could be an issue if margins are deep -Concern is that cement can interfere with healing and integration of bone, if we place an implant immediately after extracting a tooth -Screw retained margins are shown to be superior to any cement margin -Screw retained is better for immediate loading, and allows splinting for multiple implant cases
Impression	-Screw retained is more easily picked up in impressions -Gives a better duplication of seating from cast to patient
Long term treatment planning	-If natural teeth are lost next to an implant, it is better to have screw retained -Screw retained allows you to modify the restoration at a cheaper cost -Screw retained allows existing components to be used and expanded when teeth are lost

- Clinical parameters for implant evaluation

Mobility	-Initial mobility is ok during osseointegration, but not during follow ups -Implants with less advanced peri-implantitis may appear immobile due to remaining osseointegration
Suppuration	-Suppuration visible with the naked eye indicates peri-implant lesions
Peri-implant probing	-Successful implants generally allow probe penetration of 3mm -Pockets $\geq$5mm is a sign of peri-implantitis -Recession may hide what would have been a deep pocket
Clinical indices	-Peri-implantitis: swelling, redness, BOP -Absence of bleeding indicates strong periodontal stability, but BOP doesn't confirm disease -Plaque index and bleeding index are good ways to monitor OH and mucosa health

- Complications of dental implants

Statistics	-13.9% overall complication rate, with 53.2% being minor -Main risk factors for complications: smoking during implant placement, undergoing reconstruction, placement in the maxilla, and 1 stage implants -Other risk factors: poor OH, operator inexperience, lack of KT, loose abutment screws
Types of complications	-Inflammatory > prosthetic (2.7%) > operative (1%) -Inflammatory: peri-implantitis, impaired healing, recession, pain, mobility, infection. Half of complications were major issues -Prosthetic: excessive loading, anterior vs posterior, insufficient #, abutment material, implant <3.5mm -Operative: inexperience, severe bone loss, pressure on nerve due to edema, elevated temperatures due to conduction through implant, scar formation
Decreasing complications	-2 stage implants, encouraging smoking cessation -Engage patient in more informed discussion of treatment options

- Avoiding surgical complications in implant surgery

Soft tissue complications	Hemorrhage	-Bleeding depends on flap size, soft tissue management, patient anatomy, patient health **Petechiae, ecchymosis, hematomas** -24% of implant sites have ecchymosis -May extend to inferior border or chest -Avoided by avoiding vertical releasing incisions, resting elevators on bone, suctioning on bone, applying pressure for initial hemostasis **Blood loss** -Depends on time needed, size of surgery, vasoconstrictor use, blood pressure -Use caution in placing implants on submand/sublingual recesses -Bleeding can cause swelling, tongue displacement, and obstruction of airway -Obstruction of airway → transfer to hospital **Managing bleeding** -Use epi in anesthetic -Apply direct pressure -Burnish bone to occlude it if hemorrhage is coming from bone -Could litigate blood vessels, do deep sutures, and have good flap adaptation
	Nerve injury	-Nerve can be damaged during osteotomy or implant placement -Could be due to direct nerve contact, or due to bone/soft tissue compression on nerve -Nerve injuries: neurapraxia (compression), axonotmesis (severe compression or traction), and neurotmesis (disruption) -Symptoms: paresthesia, hypoesthesia, hyperesthesia, dysesthesia, anesthesia **Management** -Take radiographs to see implant, may need CT scan -If in canal, remove or withdraw implant -If not in canal but patient has symptoms, then withdraw slightly to decompress bone **Avoidance** -Careful planning (2mm safety margins) around nerves -Do a CT scan or surgically expose the mental foramen, just in case there is an anterior loop you don't know about -Also be aware of the lingual nerve and infraorbital nerve
	Tissue emphysema (crepitus)	-Air is introduced under the tissues or membranes -Air follows fascial planes → unilateral enlargement of facial or SM regions -Palpating the area may feel a cracking, crepitus sensation as air is pushed around -Treated with ABX and mild analgesia -If there is mediastinum involvement → airway distress → go to hospital
	Infections	-2g amoxicillin 1h before procedure is adequate prophylaxis -Further coverage may be needed in multiple implants, grafting, or immunocompromised
	Wound dehiscence	-Incision line breakdown sometimes happens in the first 10 days -Wound will heal by secondary intention -Most common post-op complication of submerged implants is dehiscence (4.6~13.7%) -Factors: infection, poor suturing, flap tension, poor flap design -Ensure flap is passive and tension free -Ensure overlying denture is adequately relieved and antagonistic teeth do not contact the area -Wound dehiscence increases when barriers are placed with bone grafts -Management -Resuture if within 24~48 hours -If wound margins are traumatized, in anterior, or membrane is used, use CHX BID or abx
	Aspiration	-Refer to hospital
	Pain control	-Atraumatic can reduce pain

Hard tissue complications	Periapical pathosis	-Poor positioning of implant → devitalize an adjacent tooth -Overheating of bone → devitalize an adjacent tooth **Causes of implant lesions** -PA lesion on adjacent tooth spreads to implant -Implant is contaminated during placement -Bone turns necrotic during osteotomy -Residual foreign bodies in bone **Avoiding complications** -Take radiographs, measure pre-operatively, and use guide pins during osteotomy -Avoid immediate implant placement if you see a pathosis -Debridement and irrigation may be enough to provide a proper environment -Do RCT's on teeth that need it, prior to placing any implants **Management** -If symptomatic, do a surgical debridement and antibiotic therapy as needed -If it cannot be debrided, resect and do a bone graft
	Mandibular jaw fracture	-Could happen if implant is placed on an atrophic mandible -Risk factors: osteoporosis, stress at implant, trauma, long and wide implants **Management** -Minimal mobility and displacement: leave implant there -Mobility and displacement: closed/open fracture reduction +/- retention of implant along fracture line
	Lack of primary stability	-Make the osteotomy deeper or wider, with a larger implant -Could add bone with an amalgam plugger around the implant -If it's still loose, remove implant → bone augment → re-enter in several months
	Penetration into sinus/nasal fossa	-Minor issue as long as we have enough bone to place a stable implant -usually well tolerated if it's several mm into fossa -Give Abx and a decongestant
	Complications associated with sinus lift	-25~40% chance of perforation of membrane during sinus lift -Membrane perforation did not worsen implant survival -Occlude the perforation with a barrier before grafting -Excessive bleeding during osteotomy -Severed blood vessel in bone -Place gauze saturated in 1:50,000 epi + lido or crush bone with a hemostat -Bleeding from bone is stopped via direct pressure or cautery -Septae (between 5 and 6) can complicate membrane elevation -Implant placed inadvertently into sinus must be removed via a window -Infection of sinus → abx +/- incision and drain if there is fluctuance -May detect lesions in sinus
	Medical conditions affecting success of implants	-Bisphosphonates and radiation therapy

- Indications for bone augmentation for implants

Augmenting resorbed ridges	-Implants in resorbed ridges may be unsafe and hard to position correctly -Bone augmentation adds bone volume and provides patients with proper inter-arch dimensions for better esthetics -Implant can be placed at the same time as augmentation, or it may require healing prior to placement
Types of grafts	-Guided bone regeneration -Works for horizontal augmentation on thin ridges (2.9mm thick) -Works augmenting vertical defects -Vertical defect of 4.1mm had 3mm gain with GBR + immediate implant placement -Vertical defect of 4.7mm had 4mm gain with GBR + delayed implant placement -Bone block grafts -2 stage approach was able to expand 3.2mm horizontal bone to 4.3mm -2 stage approach was able to expand vertical bone by 4.7mm -Distraction osteogenesis -7mm of vertical gain can be achieved -Ridge splitting or expansion -Horizontal bone gain of 2.95mm can be observed -Osteotomies of ridges or jaws -Combination of the above **Summary: horizontal augmentation** -When crests are <3.5mm thick, delayed implant placement is essential. Augmentation methods can be bone blocks or GBR (GBR = less augmentation potential) -Ridge splitting can also be done, but high complication and less augmentation **Summary: vertical augmentation** -GBR can be used with immediate implant if vertical defect is <4.1mm ->4.7mm defects need a delayed implant -Block bone can add 4.7mm of bone, but high risk of complications and 88% survival -Distraction osteogenesis can get 7mm of gain, but also high risk **Atrophic edentulous jaws** -Le fort I osteotomy is used, then other bone augmentation procedures are used

- Zirconia in fixed implant prosthodontics

Mechanical properties	-Low thermal conductivity, low corrosion, good radiopacity, high flexural strength, high fracture toughness -Zirconia abutments perform similar to metal abutments biomechanically -Less prone to plaque accumulation, and good biocompatibility with soft tissue
Zirconia as a restorative material	**Low temperature degradation** -Causes accelerated aging of the material, as the humid environment causes tetragonal zirconia to go to the monoclinic phase -Initiates at surface grains, proceeds to bulk material, then weakens it -Applying a thin coating of porcelain glass can prevent this from happening **Veneering ceramic failure** -Veneer ceramic and zirconia have different thermal expansion rates, causing fracture -Also, veneer ceramics are weak even at low loads -Chipping of zirconia is the most common complication **Framework design** -Shape of pontic affects stress distribution, fracture strength, and fracture mode of implant supported zirconia FDP's
Zirconia as implant restorations	-Chipping may be seen around the screw access hole. Also, an unacceptable amount of veneer chipping failures were seen -Possibly due to no proprioception, no PDL -Zirconia in a cantilever FDP showed poor fracture resistance, not recommended
Clinical protocols	-Sandblast or grind the inner surface for better cementation -Pay special attention to static and dynamic occlusion -Only adjust with fine diamonds and polish afterwards
Future	-CAD/CAM zirconia coping with lithium disilicate on top → superior to veneer ceramic on zirconia -Or, full lithium disilicate or ceramic composite materials could replace zirconia