

2 – Single Tooth Preparations

Goals of Prosthodontics

- Requires knowledge of concepts
- Knowledge of procedure
- Correct abnormalities
- Restore function
- Restore appearance
- Maintenance of remaining tooth structure and supporting structures
- Prevention from further injury

- Diagnosis – systematic evaluation of condition of patient when he/she presents for treatment
 - Patient’s interview, clinical exam, radiographs, study casts, special tests
 - Problem identification
 - Function, comfort, esthetics, longevity, cost
- Treatment Plan – reestablish a well functioning oral relationship that is biologically and mechanically sound
 - Blueprint for prosthodontics goal
 - Problem solution

- Tooth Preparation Requirements
 - Crown-root ratio = tooth inside alveolar bone vs outside it – 2:3 ratio optimum, 1:1 acceptable
 - Adequate height = 3-4mm
 - Crown lengthening if necessary
 - Buildup if necessary with – amalgam, composite, glass ionomer, cements
 - Biological width – combined CT and junctional epithelial attachment superior to crestal bone
 - 2mm total
 - Margin must be 1-2mm above biological width (gingival sulcus = 1mm)
- Retraction Cord
 - Copper band, plain cotton cord, retraction cord with epinephrine and hemostatic agents, surgical rotary curettage and electro-surgery

3 – Primary Impression and Diagnostic Cast

- Master Cast – used to fabricate a dental restoration/prosthesis
- Diagnostic Cast – life size reproduction for purpose of study and treatment planning

Impression	Diagnostic Cast
<ul style="list-style-type: none"> - Working time = mixing time + loading time <ul style="list-style-type: none"> ○ Mixing time = 1min ○ Loading time = 30s ○ Initial set time = 2:15min ○ Setting time = 3:30min 	<ul style="list-style-type: none"> - Vacuum mixed microstone - Vibrator when pouring - Adequate base height (10-12mm) <ul style="list-style-type: none"> ○ 2 step technique ○ Fill/remove voids/bubbles - Trim and clean up cast for presentation

4&5 – Mounting Casts

- Articulator
 - Class I – nonadjustable – vertical motion
 - Class II – semiadjustable – vertical and horizontal motion
 - Class III – semiadjustable – simulates condylar pathways
 - Condylar guidance and inclination adjustable
 - Arcon – anatomically correct – condylar inclination of mechanical fossae is at fixed angle to maxillary occlusal plane
 - Non-arcon
 - Class IV – fully adjustable – simulation of most mandibular movements
 - Condylar guidance and inclination adjustable
 - Intercondylar distance can be adjusted
- Facebow – record spatial relationship between maxillary arch to some anatomic reference points to be transferred onto the articulator – orients dental cast in same relationship to opening of articulator
 - Traditional anatomic references – mandibular condyles transverse horizontal axis and nasion
 - Facebow
 - Bitefork attachment
 - Nasion relator
- Occlusion record – registration of opposing surfaces made at any maxillomandibular relationship
 - Centric record
 - Eccentric record
 - Protrusive record
 - Lateral excursive record
 - Record base – supports occluding surface when there is no 3-point contact (partially edentulous patient)
- Centric Relation – condyle in most superior-anterior position against articular eminence
 - Independent of tooth contact, clinically reproducible reference
 - Clinically discernable, restricted to purely rotary movement about transverse horizontal axis
 - Bimanual manipulation to guide jaw into CR
 - Anterior programming device – individually fabricated anterior guide table, allows mandibular movement without tooth contact, facilitates recording of maxillomandibular relationship
 - Deprogrammer – various devices/materials used to alter proprioceptive mechanism during mandibular closure
 - Leaf guage – set of blades to measure distance between 2 points or provide metered separation
 - Lucia jig – anterior deprogrammer
- Maximal Intercuspatation – complete intercuspation of opposing teeth in best fit regardless of condyles
 - Not same as CR, determination of MI or CR need to be considered for restoration
- Occlusal record used for recording CR – make sure no tooth contact while recording, leave only cusp tips only
 - DIAGNOSTIC CASTS ALWAYS MOUNT IN CR
 - Working cast mount DEPENDS ON REQUIREMENT OF TREATMENT
- Adjust incisal pin mark, increase 2-3mm of vertical dimension to compensate for occlusal record when pointing mandibular diagnostic cast

6&7 – Equilibration and Border Movements

- Centric Relation – purely TMJ – anterior-superior position
- Maximum Intercuspal Position – purely teeth – best fit of teeth
- Centric Occlusion – both TMJ and teeth – occlusion of teeth when mandible is in CR (not always same as MIP)

- Angle classification – molar classification
 - Classification based on interdigitation of first molar
 - Anterior-posterior classification
 - Class I – neutroclusion – Mx mesiobuccal cusp aligns with Mn mesiobuccal groove
 - Class II – distocclusion – Mx mesiobuccal cusp mesial of Mn mesiobuccal groove
 - Division I – bilateral distal retrusion with protruding maxillary incisors
 - Division II – retruded maxillary central incisors, labially malopposed maxillary lateral incisors, excessive vertical overlap
 - Class III – mesioclusion – Mx mesiobuccal cusps distal of Mn mesiobuccal groove

- Ideal Occlusion
 - Horizontal overlap 2-4mm
 - Neutroclusion
 - Anterior teeth vertical overlap 30-50%
 - Midlines aligned
 - Posterior teeth good cusp/fossa relationship
 - Mutually protected occlusion
 - Simultaneous contact and axial loading of posterior teeth
 - Light contact of anterior teeth, disengagement of posterior teeth during excursions

- Equilibration
 - 2.0-2.5mm enamel/restorative thickness @ cusp and fossa
 - Rule of thirds
 - Occlusal adjustment
 - Adjust for MIP, then for lateraltrusive, then for protrusive
 - Restorative treatment
 - Orthodontic treatment
 - Reduce cusps/deepen fossae
 - If not possible to get cusp to correct fossae – create flat fossae in opposing incline to receive the cusp
 - Goal – all centric cusps contacting and all posterior teeth holding shimstock

8 – Custom Incisal Guide Table

- Diagnostic wax up
 - o Space analysis
 - o Correct proportions/esthetics
 - o Establish/reestablish occlusal scheme
 - o Determine position of final restoration – establish room for restoration and substructure
 - o Determine other treatment needs – crown lengthening, orthodontics
 - o Demonstration for patient – treatment outcome
 - o Provide for preparation guide
 - o Provide for provisional crown
- Custom incisal guide table – record of occlusal scheme (canine guidance, group function, etc)
 - o Stable to provide accurate record
 - o Accurately represent border movements or functional movements of planned treatment
 - o Provide stable guidance without compromising diagnostic cast or wax up

9 – Custom Tray

- Improves accuracy of elastomeric impression material by limiting material volume
- Procedure
 - o Draw tray outline 5mm beyond margin of gingiva (duplicate cast)
 - o Use boxing wax and foil (include V-notch for canine area)
 - o Adapt tray material on top of space relief, cut excess beyond tray outline
 - o Add more tray material to cover all the area, make a handle
 - o Cure for 2 minutes, remove spacer/relief to avoid melting wax
 - o Apply air barrier coating to tray, cure for another 2 minutes
 - o Wash/clean, trim
- Putty matrice adapted on diagnostic cast (not duplicate)
- Don't forget to label
 - o Used as a prep guide and for provisional crown
- Stone can be poured into putty matrice to create a duplicate cast region
 - o Can be used to make vacuum formed matrice
 - Used for same purposes – prep guide, provisional crown

Principles of Tooth Prep

1. Conservation of tooth structure
 - Excessive reduction → thermal hypersensitivity, pulpal inflammation/necrosis, no retention/resistance
2. Retention and resistance (tension, sheer, combination, compression)
 - Prevents removal along axis of insertion and dislodgment from forces along other axis, respectively
 - Ideal taper, preserve tooth height (at least 3-4 mm)
 - Path of insertion, parallelism where needed
 - Retentive features, no undercuts
 - Preparation – primary source of retention/resistance
 - Cementation – secondary source of retention/resistance
3. Marginal integrity, preservation of periodontium
 - Well defined, continuous, even, smooth, follow's tooth contour, appropriate height, no proximal contact
 - Shoulder, chamfer, shoulder with bevel, feather/knife edge
 - Biologic width – combined width of CT and epithelial attachment superior to crestal bone (does not include sulcus). Biologic width = 2mm, sulcus = 1mm, margin distance from crestal bone = 3-4mm
4. Structural durability, esthetics
 - Avoid under reduction, sufficient occlusal clearance
 - Follow occlusal planar contours, functional cusp bevel (good clearance, contour, and taper)
 - No sharp angles or corners
 - Don't damage proximal teeth

Proper tooth prep

- Removal of tooth structure doesn't weaken tooth
- Amount of reduction follows restoration requirements
- Resists displacement from all directions
- Presence of optimum tooth height
- Robust margin with close adaptation
- Provides optimal spacing for crown: prevent fracture, distortion, perforation

Full Crown Restorations

- Artificial replacement that restores missing tooth structure by surrounding all remaining structure with material such as cast metal, porcelain, or combination.

Indications

- Maximum retention/resistance needed
- Correction of contours
- Support removal partial dentures
- Retainer for fixed partial denture
- Restoration of badly damaged tooth
- Restoration of endodontically treated tooth

Contraindications

- Patients with active caries
- Untreated periodontal disease
- Young patients with large pulp chambers

Full Gold Crown

- Minimum tooth reduction
- Badly damaged posterior teeth
- Superior strength
- 1.5mm reduction on working cusps, 1.0mm reduction on non-working cusps
- Chamfer margins 0.5mm above gingiva, biplane reduction on working cusp side with functional cusp bevel

Porcelain Fused to Metal Crown

- Considerable tooth reduction, especially on side with porcelain overlay
 - o Radial shoulder – porcelain margin
 - o Chamfer – metal margin
 - o Wing – in middle of proximal sides, for retention/resistance, preservation of tooth structure
 - o Axial reduction – retention and resistance
 - o Incisal notch – structural stability
- One of the most widely used fixed restorations

All Ceramic Crown

- Best esthetics
- Good tissue response
- Prone to fracture
- Significant tooth reduction
 - o 1.5mm incisal reduction, 1.0mm facial/lingual reduction
- Proper preparation
 - o Radial shoulder
 - o Vertical lingual wall – retention/resistance
 - o Concave cingulum reduction – structural durability
 - o Rounded edges – structural durability
 - o Axial reduction

Ergonomics

- The study of work
 - o Health of the body – flexibility, mobility, strength, endurance
 - o Posture during task performance
 - o Positioning of patient
 - o Instruments
 - o Design of unit/operator
 - o Time and effort to accomplish a task
- 80% of dentists who retire early > 50 years old
 - o 29.5% musculoskeletal injury
 - o 21.2% cardiovascular problems
- Factors increasing risk of injury = force, repetition, posture
 - o Typical working posture of a dentist
 - 1/3 time = 0-18°
 - 2/3 time = 19-54°

Good ergonomics

- Posture
 - o Neutral/balanced position
 - o Trunk 100-110°
 - o Not leaning, not rotated
 - o Weight evenly distributed
 - Tripod position
 - Lean in from the hips (hinge point)
 - Back straight – 12 lbs of head, 12 lbs on upper back
 - If posture is bent, 36 lbs on upper back, 12 lbs supported by neck
 - Back risk factors:
 - o Forward bending >20°
 - o Back twisted
 - o Bent sideways with shoulders not parallel to floor
 - Shoulders and elbows down
 - Shoulder risk factors:
 - o Arm raised >45°, lack of upper extremity support
 - o Prolonged static neck and shoulder flexion
 - o Patient seated too high
 - Neck slightly bent – forward inclination <20°
 - Neck risk factors:
 - o Inclination > 20°
 - o Neck inclined or tipped backward
 - o Twisted or bent sideways
 - o Wrists/hands
 - Risk factors:
 - Pinch grip
 - Flexion or extension >45° – Radial and/or ulnar deviation

Patient positioning

- Get patient over towards you at appointment beginning
- Move/align the patients head for easier access to oral cavity
- Maxillary vs mandibular arch positioning – 8:00, 9:00, 11:00 positions
- Align chair height for proper focal distance

General Tips

- Chest high, head high
- Trunk supported/stabilized
- Maintain alignment of hips, keep trunk/shoulders/head in good alignment
- Neck flexion 15-20° max – allows for vision

Esthetic Finish Lines

Feather/Knife edge – Long, shallow bevel nearly parallel to axial surface

Advantages	Disadvantages
<ul style="list-style-type: none"> - Conservation of Tooth Structure 	<ul style="list-style-type: none"> - Insufficient metal bulk at margin - Distortion upon waxing/casting - Marginal openings - Over contoured restorations - Opaque restorations - Unable to support porcelain - Difficult to read margins on die - Difficult to provisionalize
Technique	Indications
<ul style="list-style-type: none"> - FL210, FL240 - Smooth continuous motion → formation of shallow bevel nearly parallel to axial surface 	<ul style="list-style-type: none"> - Tilted teeth - Overly convex axial surface <ul style="list-style-type: none"> o Lingual side of mandibular molars - Generally contraindicated

Chamfer

Advantages	Disadvantages
<ul style="list-style-type: none"> - Experimentally exhibits less stress on underlying cement - Acute edge at margin with nearby metal bulk <ul style="list-style-type: none"> o Less distortion, easier margin detection/finish 	<ul style="list-style-type: none"> - Aggressive preparation of tooth - May leave unsupported enamel lip
Technique	Indications
<ul style="list-style-type: none"> - 8C50, 8C75 - Smooth continuous motion 	<ul style="list-style-type: none"> - Cast metal restorations - Lingual margin of PFMs

Heavy Chamfer

Advantages	Disadvantages
<ul style="list-style-type: none"> - Good support for all ceramics - Acute edge at margin, nearby metal bulk <ul style="list-style-type: none"> o Less distortion, easier detection/finish 	<ul style="list-style-type: none"> - Challenging preparation - Aggressive preparation - May leave unsupported enamel lip
Technique	Indications
<ul style="list-style-type: none"> - 8R1 - Smooth continuous motion 	<ul style="list-style-type: none"> - Al ceramic crowns - Premolar-premolar PFM restorations - Disappearing margins

Shoulder

Advantages	Disadvantages
<ul style="list-style-type: none"> - Minimizes stress on porcelain - Wide ledge – resistance to occlusal forces - Optimal esthetics 	<ul style="list-style-type: none"> - Aggressive preparation - 90° angle conducive to coronal tooth fracture
Technique	Indications
<ul style="list-style-type: none"> - 8F100 - Smooth continuous motion - Formation of flat ledge (1.0-1.3mm) - 100-110° internal line angle 	<ul style="list-style-type: none"> - All ceramic crowns - Facial of anterior PFM crowns - High esthetics - Contraindicated for FGC

Shoulder Bevel Finish Line

Advantages	Disadvantages
<ul style="list-style-type: none"> - Conservative extension of existing preparation 	<ul style="list-style-type: none"> - Technically challenging - Danger to periodontium if used improperly - Esthetic limitations
Technique	Indications
<ul style="list-style-type: none"> - Shoulder formation, then: - DE11/12 or DE15/16 (30-45° bevel) - Smooth continuous motion 	<ul style="list-style-type: none"> - Inlays, onlays - 3/4 and 7/8 crowns - PFM where gingival esthetics not critical - Extension of shoulder preparation formed by previous restoration or due to recurrent decay

Radial Shoulder

Advantages	Disadvantages
<ul style="list-style-type: none"> - Less stress placed on tooth - Good porcelain support - Optimal esthetics 	<ul style="list-style-type: none"> - Technically difficult - Aggressive preparation
Technique	Indications
<ul style="list-style-type: none"> - 8F100 → 8R100 → modified bi-angle chisel 1. Formation of flat ledge 2. Rounded internal line angle (100-110°) 3. Chiseled edge to finish margin periphery 	<ul style="list-style-type: none"> - All ceramic crowns - PFM porcelain butt margins in esthetically sensitive areas (no metal collar)

Special Considerations

- Porcelain support – radial shoulder → shoulder → heavy chamfer → chamfer → knife edge
- Preston/disappearing margin
 - o Metal coping extends from axial wall just short of cavosurface → allows porcelain coverage of margin
 - Shallow preparations – weak porcelain, opaque cervical region, metal visible, bulky restoration
- Margin contours
 - o Smooth continuous margin easily accessible for hygiene

Margin Placement

1. Supragingival
 - a. Easy preparation – good visualization
 - b. Impression technique and provisional crowns less traumatic
 - c. Allows for good hygiene
 - d. Esthetic limitations
2. At gingival tissue crest
 - a. Easy preparation – good visualization
 - b. Less traumatic – noninvasive of gingival tissues
 - c. Allows for good hygiene
 - d. Esthetic limitations

3. Subgingival
 - a. Margin invades sulcus (0.69mm) → inflammatory response
 - b. Difficult to detect margin discrepancies
 - c. Should not extend to epithelial attachment
 - i. Biological width – 2mm circumference band of tissue
 1. Gingival inflammation
 2. Loss of alveolar crest height
 3. Formation of periodontal pocket
 4. Gingival recession
 - d. Margin should be $< \frac{1}{2}$ gingival sulcus depth, >2 mm from alveolar crest
 - i. Surgical crown lengthening to place bone 3mm away from desired margin placement
 - ii. Tooth extraction if location is interproximal/adjacent to another tooth
- Indications for Subgingival margins
 - o Previous subgingival margin preparation
 - o Esthetic demands
 - o Caries, trauma, tooth fracture
 - o Ferrule (metal ring/collar)
 - o Lack of resistance and retention form

Finish Line Selection Criteria

1. Type of crown/retainer
 2. Esthetic requirements – finish line location
 3. Easy of formation
 4. Personal experience
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- Metal restorations – chamfer (0.3m-0.5mm minimum depth)
 - PFM – chamfer, heavy chamfer, radial shoulder, shoulder, beveled shoulder
 - All ceramic crowns – radial shoulder, shoulder, chamfer

14 – Provisional Crowns

- Interim prosthesis – enhance esthetics, stabilization/function for limited time period, replaced by definitive dental/maxillofacial prosthesis

Requirements

- a. Pulp protection – material doesn't conduct heat, well adapted margin
- b. Positional Stability – should not extrude or drift, presence of proximal contacts
- c. Occlusal function – occlusal function and prevent tooth movement, presence of occlusal contact
- d. Easily cleaned – follows contour of tooth, adequate embrasure
- e. Non-impinging margins – gingival protection, no overhang
- f. Strength/retention – material integrity, adequate thickness
- g. Esthetics – important for anteriors and premolars, colour matching

Fabrication Techniques

- Direct
- Indirect – requires duplicate cast, good for multiple teeth
- Vacuum formed matrice

15 – Final Impression

- Gingival displacement – deflection of marginal gingiva away from tooth, gingival retraction of junctional epithelium without damaging connective tissue attachment (deflecting part of the biologic zone)
 - o To control bleeding
 - o To provide access of margins for final impression
- Single cord – placed in sulcus, removed before impression
- Double cord – placed one above the other, one *OR* both removed prior to impression

Acceptable impression

- Exact record of all aspects of prepared tooth
- Includes adjacent unprepared teeth
- Includes cervical contour of prepared tooth margin
- Includes all teeth in arch and soft tissues

Impression material – elastic material placed inside tray inserted into patient's mouth

- Irreversible hydrocolloid
- Reversible hydrocolloid
- Polysulphide polymer
- Condensation silicone
- Polyether
- Addition silicone (used for fixed prosthodontics)
 - o Polyvinylsiloxane (PVS) – 2-paste system (base and catalyst)

Clinical properties of impression materials

- Hydrophilicity (surface moisture affinity), wetting (ability of liquid to spread over surface), contact angles (measure of wetting)
- Consistency – 4 viscosities measured by ADA Spec 19
 - o Low – syringe or wash material
 - o Medium or monophasic
 - o High – tray or heavy material
 - o Very high – putty
- Surface detail – ability of material to accurately reproduce surface of an object (low viscosity = better detail)
- Working Time – mixing to load into tray, affected by temperature
- Setting Time – placed in oral environment, linear shrinkage during polymerization compensated by dental stone expansion during pouring
- Others – elastic recovery, flexibility, high tear strength, dimensional stability

Impression Critical Errors

- Tissue or contact with tray
- Not enough wash or tray material
- Voids/bubbles, tearing, pulls/drag
- Inadequate margins
- Inadequate tray adhesion
- Delamination/lack of coadaptation
- Do not reline bad impressions

16 – Working Casts and Dies

- Requirements of working casts:
 - o Die – removable preparation
 - o Removable proximal contacts
- Neatness and cleanliness are vital
- Look for margins and voids
- VPS can be repoured 1-2x MAX if margins undamaged and not separated from tray
- Impression trimming (trim down to tray)
 - o Facilitates removal from cast
 - o Prevents distortion (repouring)
 - o Facilitates boxing
 - Importance of boxing – sawed and pinned segments cannot be added to once stone has set

Cast Preparation

1. Seal rope wax flush to edge of custom tray
2. Lute boxing wax to rope wax
3. Wet impressions with water, shake out excess
4. Use type IV gypsum for all die work (never use slurry water)
5. Carefully overfill preparations with small non-perforating instrument under vibrator
6. Fill remainder of impression to >12mm above free gingival margins
7. Stone sets minimum 1h
8. Pry gently, remove remaining wax with knife prior to trimming, peel wax just before stone becomes exothermic
9. Trim lingual stone carefully with large brasseler bur (don't pinch)
10. Trim posterior of cast first, then carefully trim base until perfectly flat to 10mm from free gingival margin
 - a. Trim for even thickness, if base isn't flat pindex won't reach proper depth and pins won't be parallel
11. Cut out inside boxing wax
12. Check if pindex drill is broken off – should extend 6mm above table
13. Laser light shows where hole will be – keep drilling until light turns off (hole reaches required depth)
 - a. Drill at least twice to remove shavings
 - b. Edentulous areas for bridgework must be pinned
14. Use #8 round bur to create indices – prevent rotation of dies, indicate pin location when base is poured
15. Dip pins in superglue, place into holes (don't pour glue into holes), remove excess
16. Sleeves placed on only after glue has dried

Base Preparation

1. Lute wax to cast on outside (wax won't get on surfaces base is poured onto)
 - a. Seal well on dried stone, or will come off on vibrator
2. Lingual wax piece should allow room for saw and prevent stone from locking die to base
3. Adapt boxing wax around cast (and rope wax), seal tightly with hot instrument or will come off on vibrator
 - a. A second piece of boxing wax to protect teeth from stone on vibrator is optional
4. Use supersep before adding stone base (removal of base from cast impossible without supersep)
 - a. Leave for 20-30 seconds, too long and it will separate wax from cast
5. Use type III stone for base, do not cover black pin caps
6. Trim base to be flush with cast carefully
 - a. Don't trim pins or they mushroom and cannot be removed
7. Mark saw lines in blue
8. Tap lightly on robinson brush to separate dies from cast (entire arch can separate from pushing on the pins)
9. Angle saw cuts so dies are removable without removing contact areas
 - a. Be careful around the margin
 - b. If sawing from below saw to 1mm from margin and pinch to break remainder
10. Use brasseler bur to provide access to ends of long pins
 - a. Allows for die removal from pushing up on pins instead of pulling on dies
11. Index cast
12. Block exposed pins to protect from mounting plaster
13. Examine articulation closely when relating casts – remove bubbles and defects before mounting
14. Casts MUST be attached to each other – plaster shrinkage during setting causes casts to unrelated
 - a. Mount against diagnostic cast to maintain jaw relation
15. Check mounting and equilibrate casts using articulation ribbon
 - a. Check for wear facets on teeth
 - b. Carefully remove high spots with discoid-cleoid
16. Place patient's name and date on casts

Die Preparation

1. Use a brasseler bur to take away major excess around the margins
2. Identify the finish line (margin) in red
3. Soak the die in supernatant from slurry water
4. Carefully, using scalpel, clear away minor excess around the margins
 - a. Carve apically, away from margin
5. Paint die with die spacer (2 layers) leaving about 1mm uncoated above the margin
6. Soak a cotton tip in superglue, roll it over margin to reinforce margin stone
7. Apply dielube (separator) to die
8. Wax up tooth
 - a. Check for clean margins
 - b. Check for occlusal contacts
 - c. Check for excursive movements
9. Make good casts, mount cleanly, good clean organized mounted casts present well to technicians, better impression of what the end work is worth to the practitioner

18 – Shade Selection

Light and Colour

- Colour – the quality of an object/substance with respect to light reflected by the object, usually determined by measurement of hue, chroma, and value

Description of light

- Influenced by 3 factors
 1. Physical properties of object
 2. Assessment of the observer
 3. Nature of incident light
 - o Relationship to other coloured objects
- Part of EMR spectrum, eyes only sensitive to visible portion (380-750nm) – purple – red
 - o Shorter wavelengths (purple) bend more than longer ones (red) – ROYGBIV

Quality of Light

1. Incandescent light – emits lots of yellow, low CRI (colour rendering index), not suitable for shade matching
 2. Fluorescent light – emits lots of blue, CRI = 50-80, not suitable for shade matching
 3. Natural daylight – sets standard, northern daylight best, closest to emitting full white light spectrum, CRI ~ 100
- Colour rendering index (CRI) – indicates how well a light source renders colour as compared to the standard source (northern daylight). Affected by:
 - o Time of day
 - Morning/evening – shorter wavelengths scatter before penetrating atmosphere (yellow/red abundant, lacks blue/green)
 - Midday – ideal around noon, incident daylight more balanced within VLS
 - o Cloud cover
 - o Humidity
 - o Pollution
 - Color Temperature – another light source reference standard, related to color standard black body when heated
 - o Also dependent on 4 factors that influence CRI
 - 1000K – red
 - 2000K – yellow
 - 5555K – white
 - 6500K – northern daylight
 - 8000K – pale blue

Subtractive Colour (Red, Yellow, Blue)

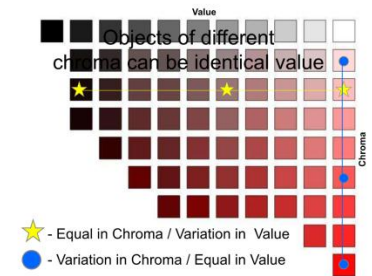
- Secondary – violet (red and blue), orange (yellow and red), green (yellow and blue)
- Paints/inks/fabrics, mixing gives black

Additive Colour (Red, Blue, Green)

- Secondary – magenta (red and blue), cyan (blue and green), yellow (red and green)
- Emitted light, combined gives white

Three Attributes of Colour

- Hue
 - o Variety of colour (red, green, blue, yellow, etc)
 - o Determined by wavelength of observed light within VLS, reflected wavelength determines hue
- Chroma
 - o Intensity/saturation of a hue
- Value
 - o Relative darkness or lightness of a colour
 - o 0-10 (0 = black, 10 = white)
 - o Amount of light energy and object reflects/transmits
 - o Objects of different hue/chroma can be identical in value
 - Restorations too high in value easily detected



Colour Perception

- Rods
 - o Scotopic vision (grey scale) – interpret brightness
 - o More active under dark
 - o Concentration in peripheral retina
- Cones
 - o Photopic vision (colour) – interpret hue
 - o More active under bright light
 - o Concentration in macula (central retina)
- Colour adaptation
 - o Colour vision decreases rapidly as object is observed
 - o Fatigue – colour view dulls, while its complement increases in intensity
 - o Viewing of a pale blue or gray surface will restore colour vision between shade matching
- Metamerism
 - o Metamers – two colours that appear to match under a given lighting condition but have different spectral reflectance
- Colour blindness (8% males, 0.5% females)
 - o Achromatism – complete lack of hue sensitivity
 - o Dichromatism – sensitivity to 2 primary hues
 - o Anomalous trichromatism – sensitivity to all 3 primary hues, abnormality in retinal cones affecting one primary hue

Shade Selection

- Subjective evaluation with considerable variation
- Subtle variations can exist without causing disharmony in smile (restoration contour, value of restoration)

Principles of Shade Selection

1. Teeth to be matched must be close together
2. Remove bright colours from view (makeup, tinted eyeglasses, bright gloves, use neutral operatory wall colours)
3. View patient at eye level
4. Evaluate shade under multiple light sources
5. Make shade comparisons at beginning of appointment
6. Shade comparisons made quickly to avoid eye fatigue

Commercial Shade Guides

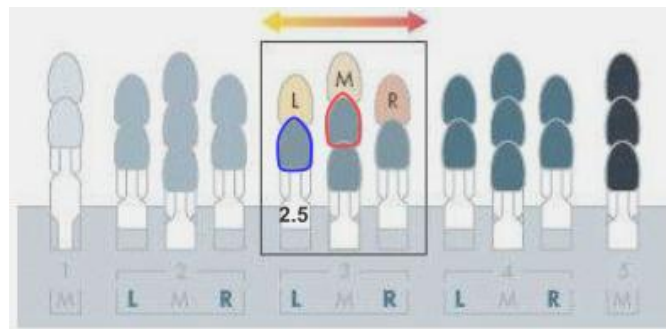
- Most convenient and common method for shade selection
- Guides consist of shade tabs (metal backing, opaque porcelain, neck, body, and incisal colour)
- Select tab with most natural intraoral appearance
- Companies/types – vita classic, vitapan 3D master, extended range shade guides,

Vita classic shade guide

- Very popular
- Tabs of similar hue clustered by letter (A – red/yellow, B – yellow, C – grey, D – red/yellow/grey)
- Chroma designated by numerical numbers (A3 – red/yellow colour, chroma of 3)
- Steps:
 1. Hue selection
 - Operator should select hue closest to that of natural tooth (A, B, C, D)
 - Use are of tooth highest in chroma for hue selection
 - Difficult to select hue for teeth of different chroma
 2. Chroma selection
 - Chroma selected from graduation of hue tabs (B1, B2, B3, B4)
 - Several comparisons should be made
 - Avoid eye fatigue, rest eyes between comparisons
 3. Value selection
 - Use of second, value ordered shade guide recommended
 - Value best determined by squatting with comparisons made at arms length
 - Decreases light
 - Diminishes cone sensitivity, increases rod sensitivity
 - Tooth fading first has lower value
 4. Final check/revision
 - Potential problems – following value selection, tabs selected for hue and chroma may not coincide with shade tab selected for value
 - Possible solutions
 - Value of shade tab < natural teeth
 - Select new shade with higher value
 - Cannot increase value of recreation with extrinsic staining
 - Will only increase opacity, decreasing transmission
 - Value of shade tab > natural teeth
 - Select new shade tab with lower value
 - Bridge differences with intrinsic/extrinsic staining

Vita 3D Master Shade Guide

1. Determine lightness level (value)
 - a. hold shade guide to patient's mouth at arms length
 - b. start with darkest group moving right to left
 - c. select value group (1, 2, 3, 4, 5)
2. Select chroma
 - a. from selected value group remove tab (L, M, R), spread samples like a fan
 - b. select 1 of the 3 shade samples to determine chroma
3. Determine hue
 - a. check whether natural tooth is more yellowish or reddish than shade sample selected
4. For more precise shade, intermediate values of hue, value, and chroma can be given



Extended range shade Guides

- Most shade guides do not cover all the colour in the natural dentition
- Some porcelain systems extend the typical range
 - o Bleaches shades, dentin shades, custom shade guides

Shade Mapping

- Recommended even when good custom shade matching exists
- Tooth is divided into a 3x3 grid (3 regions, 9 segments)
- Each region matched independently
- Further characterizations are sketched on diagram, may include:
 - o Craze lines
 - o Hypocalcifications
 - o Proximal discolourations
 - o Translucency

Summary

- Understanding science of colour and colour perception crucial for success in esthetic restorative dentistry
- While limitations in materials and techniques may make perfect colour match impossible, harmonious restoration can still be [almost] achieved
- Shade selection should be approached in methodical and organized manner
 - o Allows practitioner to make best choice and communicate it accurately to laboratory

19 – Laboratory Communication

- Dentist – quality product, consistency, timely delivery
- Lab – quality master cast, completed work authorization form, adequate working time
- ADA guidelines were created to improve dentist/technician communication

Responsibilities

- Dentist
 - o Balance between technical limitations, biological factors, esthetics
 - o Active participation
 - o Better understanding = better clinical decisions
 - o Tooth preparation
 - Under-reduced in cervical 1/3 → nearly impossible for ceramist to achieve optimal esthetics
 - Overcontouring – periodontal irritation
 - o Easily identifiable margins – if you can't see it, you can't wax it
 - o Realistic margin design
- Technician
 - o Appreciate/respect clinical rationale of dentist
 - o Active communication
- Laboratory
 - o Prosthesis as per written instructions
 - o Use of impressions, records, mountings, etc
 - o Review case with DDS if questions arise
 - o Match shade requested
 - o Notify DDS immediately if it cannot proceed
 - o Efficient timeline
 - o Include materials used
 - o Proper infection control

Work Authorizations

- Legal document
- Grants authority for laboratory to fabricate a restoration/prosthesis on dentist's behalf
- Should provide an effective channel of communication between dentist and lab
- Must include:
 - o Dentist's name AND signature
 - o Patient's name
 - o Laboratory
 - o Date of work authorization
 - o Desired date of completion
 - o Specific instructions/design requirements
 - o Materials to be used
 - o Accurate impressions, casts, mountings, interocclusal records, etc
 - o Identify margins, postdam, borders, areas of relief, prosthetic design
 - o Desired shade
 - o Follow appropriate infection control procedures

The Difficult...

Dentist

- Insufficient information on work authorization form
- Mystery margins – deficient impressions
- Inadequate tooth reduction
- Inadequate records
- Lack of communication (shade)

Technician

- Poor marginal adaptation
- Poor occlusion
- Poor axial contours (cervical 1/3)
- Deviation from ideal substructure and pontic design
- Lack of communication

Example for #30 Extra Instructions

1. Establish centric occlusal contacts (cusp-fossa)
2. No centric contacts in excursive movements; maintain anterior guidance
3. Cast in high noble alloy
4. Use solid cast to verify interproximal contacts
5. Return polished and ready for insertion [date]
6. Please call with any questions
7. Thank you!
8. Enclosed – final impression, articulator #, master cast, opposing cast, bite registration, etc

Summary

- Key to high quality restorations is communication
- In depth understanding of laboratory procedures and materials
- With time, significant improved interaction with technician and improved clinical decision making