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FUNDAMENTALS OF AESTHETIC DENTAL RESTORATION

Educational and methodical textbook

for practical classes in fundamentals of aesthetic dental restoration for 4th-year students of the dental faculty

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An educational and methodical textbook was prepared for studying the program of discipline "Fundamentals of aesthetic dental restoration" by 4th-year students of the dental faculty. The guide includes methodological developments for conducting practical classes in conjunction with control tasks and a list of recommended educational and methodological literature. The textbook is designed to improve students' knowledge of anatomical and morphological features of the shape of the teeth, principles, methods and stages of preparation carious cavities of different localization, composition, properties, and methods use of dental filling materials, principles of modeling the shape of teeth using various techniques in the performance of aesthetic restorations.

The educational and methodical textbook was reviewed and approved for publication at the meeting of the department of therapeutic Dentistry, Protocol № 1 of January 18, 2024.

CONTENTS

LIST OF ABBREVIATIONS AND TERMS

Bis-GMA	Bisphenol A-glycidyl methacrylate
CPP-ACP	Casein phosphopeptides-amorphous calcium phosphates
DEJ	Dentinoenamel junction
ETT	Endodontically treated teeth
FPD	Fixed partial denture
HFA	Health, function and esthetic triad
MID	Minimum intervention dentistry
MTTs	Matrix transfer techniques
OIL	Oxygen-inhibited layer
PTFE	Polytetrafluoroethylene
RCB	Resin-based composite
RMGICs	Resin-modified glass ionomer cements
RPD	Removable partial denture
RSM	Restorative space management
S-FPDs	Splinting fixed partial dentures

INTRODUCTION

Knowledge of anatomical and morphological features of shape of the upper and lower jaw is necessary for students' deep comprehension of cavities' restoration of I-II Black classes and modeling the shape of teeth using various techniques when performing aesthetic restorations. Ability to conduct an examination of the dental patient in the clinic of therapeutic dentistry, analysis of facial aesthetics and the initial clinical situation during planning tooth restoration.

"Fundamentals of aesthetic dental restoration" course provides study of the composition, properties of filling materials, indications and methods of their use, stages of carious cavities preparation; basic dental instruments, materials, and dental equipment in therapeutic dentistry; ability to determine the belonging of teeth to a particular group, side, maxilla or mandible, taking into account their clinical and anatomical features, signs.

Future doctors should learn to distinguish and identify the leading clinical symptoms and syndromes; by standard methods, using preliminary anamnesis data patient's history, examination data, knowledge of the person, his/her organs and systems, restoration of cavities of I-VI Black classes; modeling the shape of teeth using various techniques when performing aesthetic restorations.

Topic 1. Fundamentals of restorative dentistry, its relationship with other dental disciplines. The concept of minimally invasive dentistry. Predicting and planning the aesthetic result of restorations.

A multidisciplinary approach has become an integral part of everyday dentistry. Interdisciplinary dentistry may either be interpreted in a very narrow sense as the actual fusion of specialties, or in a wider sense as a multidisciplinary phenomenon in which independent specialties work jointly to resolve a problem, each from its own conceptual viewpoint.

PERIODONTICS-RESTORATIVE DENTISTRY INTER-RELATIONSHIP

Active periodontal disease must be treated and controlled prior to any restorative dentistry. Restorative dentistry must be performed on a periodontium free of inflammation and pockets, without any mucogingival involvement, and with the contour and shape of the periodontium corrected for a good functional and esthetic restorative result.

Restorative clinicians must understand the role of biologic width in preserving healthy gingival tissues and controlling the gingival form around restorations. One must also apply this information in the positioning of restoration margins, especially in the esthetic zone where a primary treatment goal is to mask the junction of the margin with the tooth.

A clinician is presented with three options for margin placement: supragingival, equigingival (even with the tissue), and subgingival locations. From a periodontal viewpoint, both supragingival and equigingival margins are well tolerated. The greatest biologic risk occurs when placing subgingival margins. These margins are not as accessible as supragingival or equigingival margins for finishing procedures, and in addition, if the margin is placed too far below the gingival tissue crest, it violates the gingival attachment apparatus.

Restoration contour has been described as extremely important to the maintenance of periodontal health.

ORTHODONTICS-RESTORATIVE DENTISTRY INTER-RELATIONSHIP

Occasionally, patients require restorative treatment during or after orthodontic therapy. Patients with worn or abraded teeth, peg-shaped lateral incisors, fractured teeth, multiple edentulous spaces, or other restorative needs may require tooth positioning that is slightly different from a nonrestored, nonabraded, completely dentulous adolescent. With proper planning, orthodontic treatment can create ideal anatomic space for the planned restorations, for example, when establishing slight mesial and distal spacing for anatomic restoration of a peg lateral incisor. Slightly more distal space should be established to accommodate the more convex distal line angle relative to the straighter mesial line angle of a lateral incisor.

A common orthodontic-restorative problem is peg-shaped, or malformed maxillary lateral incisors. In some patients, the best choice for treating a peg-shaped lateral incisor is to restore the malformed tooth to its correct dimension. If sufficient space exists, a composite restoration may be placed before orthodontic treatment. However, in most situations, there is insufficient space to restore the malformed lateral incisors.

Where should the lateral incisor be positioned buccolingually: toward the labial, in the center of the ridge, or toward the lingual? The answer to this question depends on the type of permanent restoration that will eventually be constructed for the tooth. In most cases, during orthodontic treatment, a temporary composite buildup is placed on a peg-shaped lateral incisor.

Any treatment modality for the crowded dentition should be designed to achieve form and function with minimal invasive dentistry. Restorative space management (RSM), is the alternative, or adjunctive. In selected cases, RSM can be used to provide an esthetic outcome by strategic removal of tooth structure and the addition, either directly or indirectly, of composite and ceramic materials.

PROSTHODONTICS-RESTORATIVE DENTISTRY INTER-RELATIONSHIP

Crowns and fixed partial dentures are definitive restorations. They are timeconsuming and expensive treatment options and should

not be recommended unless an extended lifetime of the restoration is anticipated.

A foundation restoration, or core, is used to build a damaged tooth to ideal anatomic form before it is prepared for a crown. With extensive treatment plans, the foundation may have to serve for an extended time. It should provide the patient with adequate function and should be contoured and finished to facilitate oral hygiene.

If the tooth to be restored with a cemented restoration is in a highly visible area, or if the patient is highly critical, the cosmetic effect of the restoration must be considered.

The junction between a cemented restoration and the tooth is always a potential site for recurrent caries because of dissolution of the luting agent and inherent roughness. The more accurately the restoration is adapted to the tooth, the lesser the chance of recurrent caries or periodontal disease. A well-designed preparation has a smooth and even margin. Rough, irregular, or "stepped" junctions greatly increase the length of the margin and substantially reduce the adaptation of the restoration.

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ORAL SURGERY-RESTORATIVE DENTISTRY INTER-RELATIONSHIP

One of the options for restoration of fractured anterior tooth is rebonding of the fractured fragment. Rebonding of the fractured fragment should be considered only in cases where there is no or minimal violation of biological width and the fragment is retrieved in a relatively intact condition.

Restorative treatment is based upon the results of an appropriate clinical examination and is ideally part of a comprehensive treatment plan. The treatment plan shall take into consideration:

1. The developmental status of the dentition.
2. A caries-risk assessment.
3. Patient's oral hygiene.
4. Anticipated parental compliance.
5. Patient's ability to cooperate for treatment.

The restorative treatment plan must be prepared in conjunction with an individually tailored preventive program.

Specific conditions that initiate a need for restorative dentistry are:

- Initial or recurring decay.
- Replacement of failed restorations.
- Abrasion or the wearing away of tooth structure.
- Erosion of tooth structure.

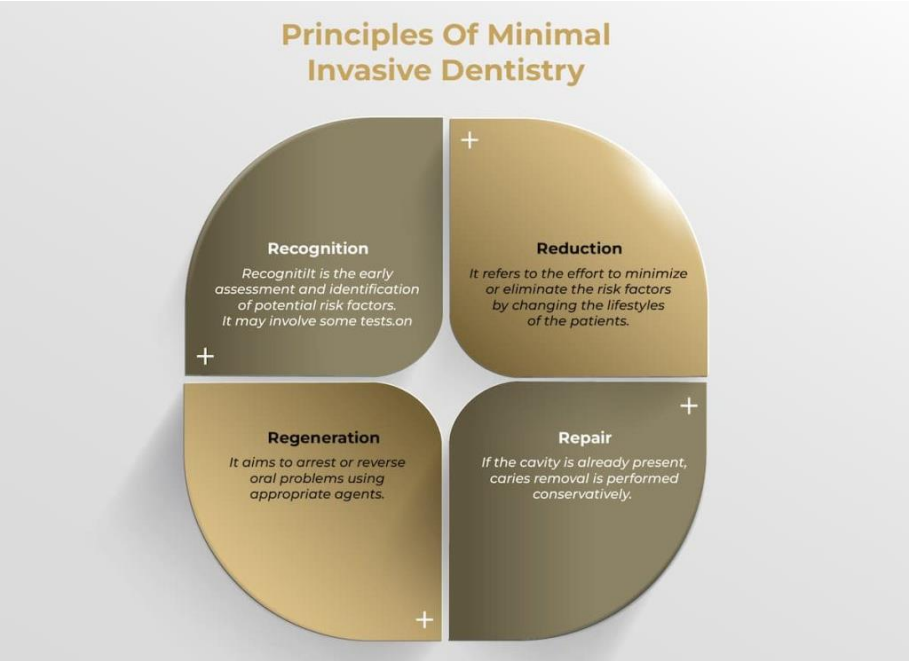
Specific conditions that initiate a need for esthetic treatment are:

- Discoloration due to extrinsic or intrinsic staining.
- Anomalies due to developmental disturbances.
- Abnormal spacing between teeth.
- Trauma.

Minimum intervention dentistry (MID) is the modern medical approach to the management of caries, utilizing caries risk assessment, and focusing on the early prevention and interception of disease. Moving the focus away from the restoration of teeth allows the dentist to achieve maximum intervention, with minimal invasive treatments. *The four core principles of MID can be considered to be:*

1. Recognition - early identification and assessment of potential caries risk factors through lifestyle analysis, saliva testing and using plaque diagnostic tests.
2. Reduction - to eliminate or minimize caries risk factors by altering diet and lifestyle habits and increasing the pH of the oral environment.
3. Regeneration - to arrest and reverse incipient lesions, using appropriate topical agents including fluorides and casein phosphopeptides-amorphous calcium phosphates (CPP-ACP).
4. Repair - when cavitation is present and surgical intervention is required, conservative caries removal is carried out to maximize the repair potential of the tooth and retain tooth structure. Bioactive materials are used to restore the tooth and promote internal healing of

the dentine. Effective implementation of MID involves integrating each of these four elements into patient assessment and treatment planning.



Restorations can be avoided in the following situations (modified from Kidd):

1. Non-cavitated white spot lesions, such as hidden proximal lesions detected on a bitewing radiograph, if these are confined to within the enamel or are just into dentine (as they are unlikely to be cavitated).
2. Root surface lesions, both cavitated and non-cavitated, if accessible for cleaning and application of topical remineralizing products.
3. Recurrent lesions adjacent to restorations – if both small and cleansable.
4. Large cavitated lesions accessible to plaque cleansing (no overhanging enamel) – where loss of function and aesthetics is acceptable.

The key principles of minimal invasive cavity design for an adhesive permanent restoration can be summarized as follows:

1. Minimize tooth structure removal so that the preparation follows the shape of the lesion, and is sufficient to achieve visual and instrument access to the caries.
2. To achieve a predictable marginal seal, remove demineralized dentine around the full cavity periphery.
3. No flat cavity floor is required.
4. Create rounded internal cavity angles; occlusal keys or dovetails are not required. Some internal cavity resistance form or small proximal retention slots can be placed to reduce stresses on the bond to dentine.

Topic 2. Anatomical and morphological features shape of the upper and lower jaws' teeth and their importance for the successful outcome of aesthetic restoration.

The clinical crown of each tooth is divided into surfaces that are designated according to their related anatomic structures and landmarks.

- Buccal surface: Tooth surface facing the check.
- Labial surface: Tooth surface facing the lip.
- Facial surface: Labial and buccal surface collectively form the facial surface.
- Mesial surface: Tooth surface towards the anterior midline.
- Distal surface: Tooth surface away from the anterior midline.
- Lingual surface: Tooth surface towards the tongue.
- Occlusal surface: Masticating surface of posterior teeth (in molars and premolars).
- Incisal surface: Functioning/cutting edge of anterior tooth of incisors and canines (cuspids).
- Gingival surface: Tooth surface near to the gingiva.
- Cervical surface: Tooth surface near the cervix or neck of the tooth.

Anatomic crown: It is part of tooth that is covered with enamel. It extends from cementoenamel junction (CEJ) to occlusal or incisal surface

Clinical crown: It is part of tooth that is visible in oral cavity. In case of gingival recession, the clinical crown is longer than anatomical crown.

Each incisor has five surfaces, each one named according to the anatomical structure that it faces:

- Labial surface - faces the lips.
- Lingual surface - faces of the mandibular incisors face the tongue. The corresponding maxillary incisors have a palatal surface instead of a lingual one that faces the hard palate of the oral cavity.
- Mesial surface - medial surfaces of the incisors. This surface is located closer to the front of the mouth and midline.
- Distal surface - the surface located lateral or distal to the midline and closer to the back of the mouth. The mesial and distal surfaces of two adjacent incisors create a contact zone. The exceptions are

the central incisors, where the contact zone is formed by their two mesial surfaces.

- Biting or incisal surface - the portion of the crown furthest away from the apex. This portion of incisors is sharp and straight to facilitate cutting food. The junction of the incisal and labial surfaces is called the incisal edge.

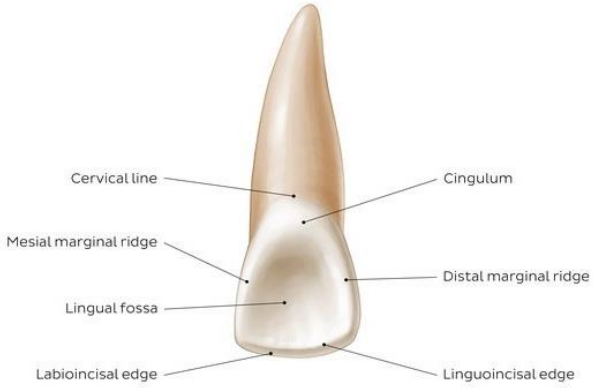
Maxillary central incisor

The two maxillary central incisors are part of the maxillary dental arcade, either side of the midline. They are the most prominent teeth, having a rectangular or square shape. Each maxillary central incisors measures approximately 22.5 mm in length, half of which (10-11 mm) represents the crown.

Labial surface. Maxillary central incisors have the largest mesiodistal distance out of all members of this group, but the least convex labial surface. However, the crown surface of the labial face is smooth. The mesial and distal crests of curvature on this face provide the contact points between neighboring incisors. The crown portion located mesially on the labial face has a small degree of convexity. In turn, the portion located distally is a lot more convex than the mesial part. The mesial and distal portions of the crown contribute to the formation of the mesioincisal and distoincisal angles, respectively.

The incisal portion of the crown may have protuberances (mamelons), but they are usually obliterated in adults. Therefore, this portion is usually straight and regular. The cervical portion of the crown is semicircular, following the curvature of the root. The root appears conical when viewed from the labial surface, with a blunt apex. The mesial and distal outlines of the root are regular.

Lingual surface. In contrast to the smooth labial surface, the lingual surface is full of convexities and concavities. In addition, a convexity (cingulum) is located below the cervical portion of the crown. Marginal ridges extend mesially and distally away from the cingulum. The shallow lingual fossa is located between the marginal ridges and below the cingulum. Apart from that, the remaining crown lines are identical to the ones on the labial surface, discussed previously.

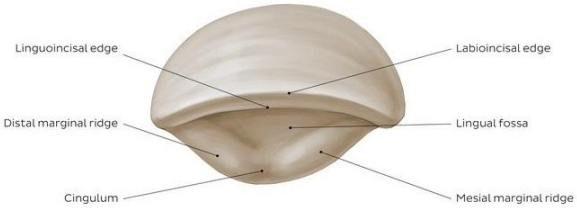


Mesial surface. The mesial aspect of the maxillary central incisors is triangular. The base is located at the cervix and the apex at the incisal ridge. A characteristic feature of these specific incisors is that the incisal ridge of the crown and the center of the tooth are perfectly aligned.

The crests of curvature of the mesial surface are coronal to the cervical line of the crown. They are located on the labial and lingual portions of the mesial aspect. After curving for 0.5 mm, the crests of curvature continue as the labial and lingual outlines. The former is slightly convex. However, the lingual outline is convex above the intersection point with the cingulum, then becomes concave, and ultimately finishes convex again close to the incisal edge. The cervical line of the mesial surface has the greatest curvature out of all surfaces and teeth in the oral cavity. The line points incisally. From the perspective of the mesial surface, the root appears cone shaped with a bluntly rounded apex.

Distal surface. The crown outlines present on the distal surface are almost identical to the ones on the mesial surface. The main difference is the curvature of the cervical line, which is less on the distal surface. In addition, the maxillary central incisors appear bigger when viewed from this perspective because a greater portion of the labial surface is visible from this angle.

Incisal surface. The crown of the maxillary central incisors appear bulkier when viewed from the incisal surface. The mesial and distal contact areas are marked by broad surfaces. The triangular outline of the incisal surface is quite uniform, except at the lingual portion which exhibits some irregularities.



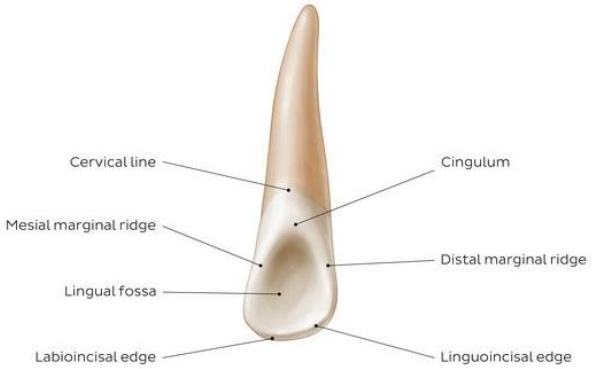
Maxillary lateral incisors

They have a very similar structure to their group neighbors, but are smaller. To be exact, the maxillary lateral incisors measure 21 mm in length. In addition, the proportion of root to crown lengths is greater in the maxillary lateral incisors. They have the second most varied structure in the entire oral cavity, after the third molar.

Labial surface. The labial surface is more curved compared to the maxillary central incisors. However, they have similar proportions. The incisal ridge and angles are rounded on the mesial and distal portions of the labial surface of the crown. The mesial outline has a rounded mesioincisial angle and a crest. The distal outline is round, having a cervical crest of contour in the center of the middle third. The labial portion of the crown has a greater convexity compared to the maxillary central incisors.

The root of these teeth tapers off apically from the cervical line. Two thirds down its length, the root curves distally, becoming pointed at its apex.

Lingual surface. The lingual aspect of the crown contains prominent distal and mesial marginal ridges. In addition, the cingulum is also markedly developed and joins the lingual fossa. The latter exhibits several deep developmental grooves and it is more concave and circumscribed than its counterpart on the maxillary central incisors. The cingulum can also contain developmental grooves, especially on its distal side. They can extend up to the entire root.

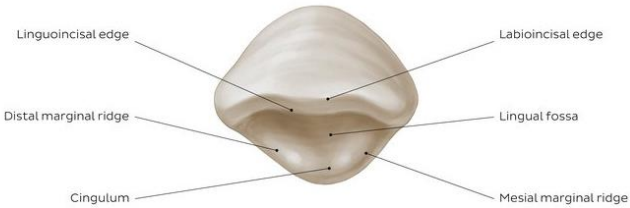


Mesial surface. The mesial surfaces of the maxillary lateral incisors share similar features to their central neighbors, with some exceptions. They have slightly shorter crowns and labiolingual distances, but longer roots. The cervical line of the mesial surface

curves towards the incisal ridge, but to a lesser extent than the one on the maxillary central incisors. The incisal ridge is also thicker. If you take a look at the root from the mesial surface, it resembles a cone with a rounded apex. Its labial outline also appears straight.

Distal surface. From the distal surface, the crown appears wide compared to the other surfaces. It also contains a developmental groove distally, which projects onto the root.

Incisal surface. The incisal surface of the maxillary lateral incisors is almost identical to the corresponding surface on the maxillary central incisors. However, their labial and lingual convexities are more pronounced, hence it is not as straight or uniform. In addition, the incisal surface of these teeth can resemble small canines.



Mandibular central incisors

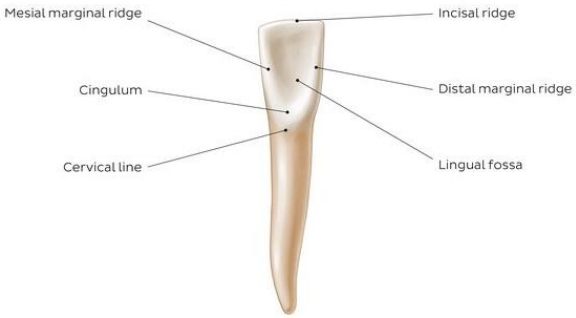
Mandibular incisors are part of the mandibular dental arch and correspond to the maxillary ones. Upon normal occlusion of the mouth, the incisal surfaces of the four pairs of incisors end up parallel to each other. The mandibular central incisors are located on either side of the midline of the mandible. They are the smallest teeth out of all of them, averaging approximately 21 mm in length.

Labial surface. The labial surface is regularly shaped and smooth. As it travels towards the root, it flattens and then becomes convex. The labial surface contains sharp distal and mesial incisal angles which taper off into the apical part of the root.

The incisal ridge travels straight and perpendicular to the long axis of the tooth. The distal and mesial portions of the crown connect the incisal angles to the contact areas of the teeth. Then, they taper off below the contact areas until the cervix. They continue straight until the apical portion of the root, where they usually curve distally. The labial surface of the root is convex and regular.

Lingual surface

The smooth lingual surface of the crown features a concavity at the incisal third between the marginal ridges. As the surface progresses towards the cervical third, it first becomes flat, then convex. The maxillary central incisors is almost devoid of developmental lines and grooves.



Mesial surface. The mesial surface of the crown is quite varied, ranging from convex and smooth to broad and flat cervical to the contact area. It becomes concave up until a point above the cervical line. When looking at the mesial surface, the outline of the labial face starts off straight, before sloping between the crest of the curvature and incisal ridge.

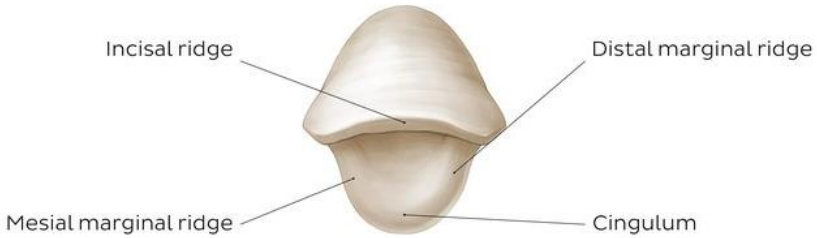
The lingual outline is partially inclined labially above the cingulum, continuing straight further down the crown. The shape of the incisal ridge is round and its center is located lingually with regards to the centre of the tooth. The cervical line shows a distinguishable curvature.

From the perspective of the mesial surface, the root appears straight, flat and with a uniform diameter. However, the root tapers off close to the apical third, becoming round or pointed at the end. The mesial surface of the root has developmental depressions along its length

Distal surface. The distal surface has a cervical line that curves in an incisal direction. On the root, there is a developmental depression with a deeply marked central groove. Apart from that, the distal surface is very similar to the incisal surface described below.

Incisal surface. The two mesial halves of the crown are identical, meaning that this entire surface of the mandibular central incisor is symmetrical. The incisal edge runs perpendicular to the labiolingual axis.

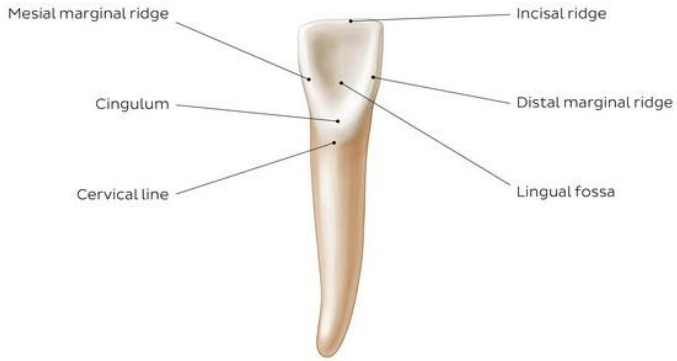
The latter has greater dimensions compared to the mesiodistal axis. In the cervical third of the crown, the labial portion is wide. The lingual area of the crown contains the cingulum. In contrast, the labial surface of the incisal third is convex, while the lingual surface of the same region is concave.



Mandibular lateral incisor

They are located on the same mandibular dental arch but more laterally. They closely resemble the mandibular central incisors and perform their function as a team, hence only the differences will be pointed out. The mandibular lateral incisors measure approximately 21 mm in length.

Labial and lingual surfaces. These two crown surfaces have a greater mesiodistal diameter in the distal half, by about 1 mm, compared to the mandibular central incisors.



Incisal surface and internal structure. The mandibular lateral incisors contain an identifiable feature on their incisal surfaces. In contrast to their central counterparts, the incisal edge of these incisors is straight, following the trajectory of the mandibular dental arch. Apart from these, their incisal surfaces are almost identical.

The pulp chambers of the mandibular lateral incisors are identical to the mandibular central ones. The only exception is that they are larger. These incisors also have either one or two roots that can curve either labially or distally.

The maxillary and mandibular canines bear a close resemblance to each other, and their functions are closely related. The four canines are placed at the "corners" of the mouth; each one is the third tooth from the median line, right and left, in the maxilla and mandible. They are commonly referred to as the cornerstone of the dental arches.1 They are the longest teeth in the mouth; the crowns are usually as long as those of the maxillary central incisors, and the single roots are longer than those of any of the other teeth. The middle labial lobes have been highly developed incisally into strong, well-formed cusps. Crowns and roots are markedly convex on most surfaces.

The shape of the crowns, with their single pointed cusps, their locations in the mouth, and the extra anchorage furnished by the long,

strongly developed roots, makes these canines resemble those of the carnivore. This resemblance to the prehensile teeth of the carnivore gives rise to the term canine.

Because of the labiolingual thickness of crown and root and the anchorage in the alveolar process of the jaws, these teeth are perhaps the most stable in the mouth. The crown portions of the canines are shaped in a manner that promotes cleanliness. This self-cleansing quality, along with the efficient anchorage in the jaws, tends to preserve these teeth throughout life. When teeth are lost, the canines are usually the last ones to go. They are very valuable teeth, when considered either as units of the natural dental arches or as possible assistants in stabilizing replacements of lost teeth in prosthetic procedures.

In function, the canines support the incisors and premo-lars, since they are located between these groups. The canine crowns have some characteristics of functional form, which bears a resemblance to incisor form and also to the premolar form.

Maxillary Canine

The maxillary canine (dens caninus maxillae) has a long, sturdy root with a stress-resistant periodontium. The root apex is slightly curved distally, reflecting the root characteristic. The pulp cavity widens in the coronal region. Viewed approximally, it is noticeable that the labiopalatal diameter is largest at the cervix. This gives the tooth its statically favorable chisel shape.

The vestibular surface exhibits the striking angular form: The cutting edge is made up of two sides of differing length inclined toward each other. The mesial side is shorter and does not recede as steeply as the longer distal side. The transitions between the cutting edge and the approximal surfaces thus lie at different heights. The mesial edge is shifted incisally, while the distal edge is displaced in a cervical direction; the mesial contact point is displaced more toward the incisal. One angle characteristic can be identified because the distal transition of the incisal margin is clearly rounded, unlike the sharp-edged mesial transition.

From the tip of the incisal edge, the sturdy medial ridge runs cervically as it changes into the prominent transverse convexity of the cervix. Poorly developed cervical grooves are found here. The medial ridge divides the labial surface into a narrow mesial and a broad distal facet.

The horizontal curvature of the canine is strongly developed, with both facets receding from the central ridge to the adjacent teeth. Both facets contain a distinct marginal ridge in the vertical direction.

The neck of the tooth is arched and contains the strong vertical curvature to protect the marginal periodontium. The approximal edges run closely together from the contact points in a cervical direction; in the middle, the distal approximal edge is rather concave centrally, whereas the mesial edge runs virtually straight.

The mesial approximal surface exhibits the pronounced wedge shape of the canine. The mesial incisal edge lies inferior to the tip of the tooth. The vertical convexities of the vestibular and lingual surfaces that protect the marginal periodontium can be seen. While the vestibular convexity runs evenly incisocervically, the lingual surface in the cervical third bends inward and only achieves the outer convexity through the tubercle. The heavy tubercle gives the tooth its bulky appearance. The cervical margin curves in an incisal direction. The tip of the canine lies centrally in relation to the base of the crown. Weak cervical grooves can be seen labially.

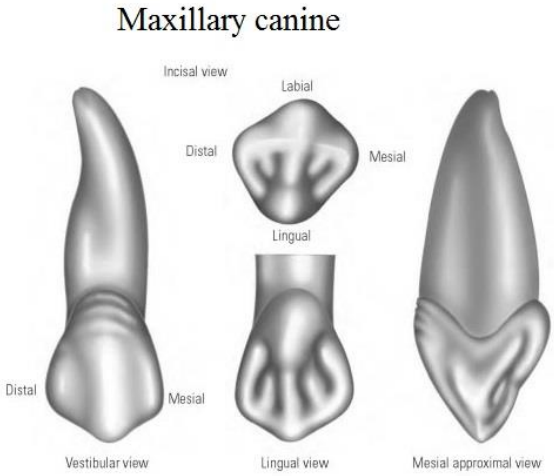
The lingual surface is smaller than the labial surface but with the same basic triangular shape. The tubercle is strongly developed. The marginal ridges are very prominent, as is a central ridge starting from the tubercle. This ridge is described as the canine guidance ridge because it is here that a certain guidance of the opposing teeth (antagonists) takes place during mandibular movement. The distal marginal ridge is developed into a strong masticatory edge incisally.

The central ridge develops cusplike into the incisal tip, which approximates to a masticatory surface in the distal portion of the crown. The cervical line is arched, and the tooth bulges out below the line to protect the gingiva.

The incisal view of the maxillary canine shows the strongly developed curvature characteristic, ie, the mesial facet is narrower than the distal, and both facets recede laterally, following the curvature of the dental arch. The strong medial ridge can be seen labially, and the cusplike tubercle is visible palatally.

The approximal surfaces are acutely angled mesially and slightly curved distally. A gentle internal curvature of the distal approximal surface serves as the contact area to the premolar. The incisal margin is curved in line with the curvature characteristic and in the distal portion is wider than the masticatory edge.

The root of the maxillary canine is usually the longest of any root with the possible exception of that of the mandibular canine, which may be as long at times. The root is thick labiolingually, with developmental depressions mesially and distally that help furnish the secure anchorage this tooth has in the maxilla.



Mandibular canine

The mandibular canine crown is narrower mesiodistally than that of the maxillary canine, although it is just as long in most instances and in many instances is longer by 0.5 to 1 mm. The root may be as

long as that of the maxillary canine, but usually it is somewhat shorter. The labiolingual diameter of crown and root is usually a fraction of a millimeter less.

The lingual surface of the crown is smoother, with less cingulum development and less bulk to the marginal ridges. The lingual portion of this crown resembles the form of the lingual surfaces of the mandibular lateral incisors.

The cusp of the mandibular canine is not as well developed as that of the maxillary canine, and the cusp ridges are thinner labiolingually. Usually the cusp tip is on a line with the center of the root, from the mesial or distal aspect, but sometimes it lies lingual to the line, as with the mandibular incisors.

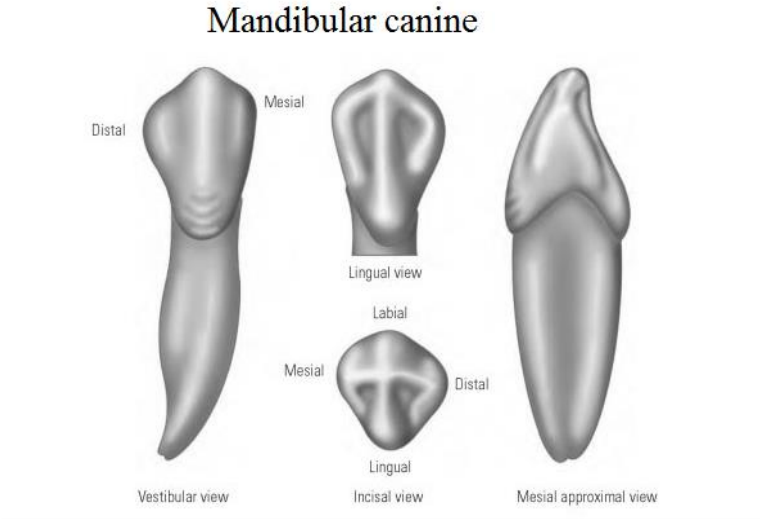
The mandibular canine (dens caninus mandibulae) resembles the maxillary canine in all characteristics; in terms of form and function, the canines bear the closest resemblance to each other of any teeth. However, the mandibular canine is much more slender and narrower than the maxillary canine, both in the crown and in the root. It has a stronger angle characteristic, with the distal transition from the incisal margin to the approximal surface located more apically than the mesial. Its root is not only much shorter, but in some cases it can be divided. The tooth may even become two-rooted. The stronger horizontal curvature characteristic is also evident; the canine tip generally is in line with the middle of the crown base. The tip of the mandibular canine abrades the tubercle and palatal medial ridge of the maxillary canine, and the teeth show corresponding wear facets.

The vestibular surface shows the typical canine shape but is narrower at the contact points in comparison with the maxillary canine; the approximal edges do not run parallel. The mesial incisal margin is shorter and higher than the distal margin, which also recedes more sharply than in the maxillary canine. This means that the distal approximal surface is extremely small. The medial ridge, marginal ridges, vertical grooves, and cervical grooves are prominent. The horizontal transverse convexity is more pronounced on the mandibular than on the maxillary canine.

The lingual surface is not as strongly developed and is less concave than in the maxillary tooth. There is a weak medial ridge, hardly any marginal ridges, and a very flattened dental tubercle; variations in ridge formation are very rare.

From the mesial approximal view, the crown appears to be inclined lingually. However, the tip of the mandibular canine, like that of the corresponding maxillary tooth, is aligned with the midline of the crown base. The appearance of an incline results from the flattened dental tubercle and the vertical curvature of the labial surface.

The incisal view shows the stronger horizontal curvature of the labial surface. The lingual surface appears to taper considerably, and the approximal surfaces are depressed. The incisal margin is more strongly angled than in the maxillary canine; the mesial edge faces the anterior teeth, while the distal edge is far more curved toward the posterior teeth. The strong development of the labiolingual diameter at the crown base is noticeable.



The premolars are so named because they are anterior to the molars in the permanent dentition. The primary difference in development is the well-formed lingual cusp, developed from the lingual lobe, which is represented by the cingulum development on incisors and canines.

The middle buccal lobe on the premolars, corresponding to the middle labial lobe of the canines, remains highly developed, with the maxillary premolars resembling the canines when viewed from the buccal aspect. The buccal cusp of the maxillary first premolar, especially, is long and sharp, assisting the canine as a prehensile or tearing tooth. The mandibular first premolar assists the mandibular canine in the same manner. The maxillary premolar crowns are shorter than those of the maxillary canines, and the roots are also shorter. The root lengths equal those of the molars. The crowns are a little longer than those of the molars.

Maxillary First Premolar

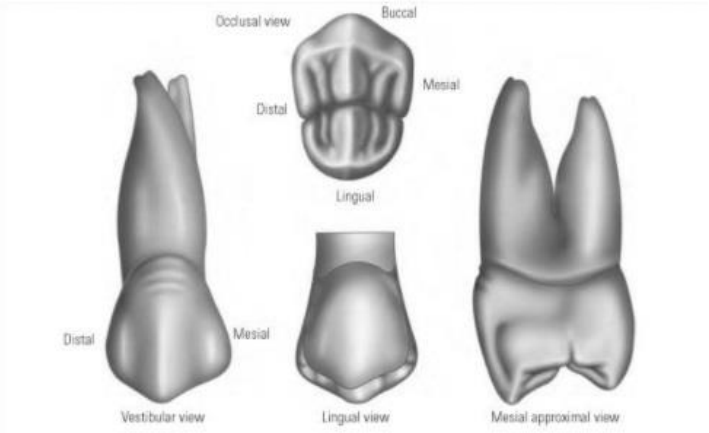
The maxillary first premolar has two cusps, a buccal and a lingual, each being sharply defined. The buccal cusp is usually about 1 mm longer than the lingual cusp. The crown is angular, and the buccal line angles are prominent. The crown is shorter than that of the canine by 1.5 to 2 mm on the average. Although this tooth resembles the canine from the buccal aspect, it differs in that the contact areas mesially and distally are at about the same level. The root is shorter. If the buccal cusp form has not been changed by wear, the mesial slope of the cusp is longer than the distal slope. The opposite arrangement is true of the maxillary canine. Generally, the first premolar is not as wide in a mesiodistal direction as the canine. Most maxillary first premolars have two roots and two pulp canals. When only one root is present, two pulp canals are usually found anyway. The maxillary first premolar (dens praemolaris medialis) usually has a divided root apex, and in some cases there may be two roots. Very rarely three root apices may be found. A buccal and palatal (lingual) root can be distinguished with independent, very branched root canals, which makes root canal treatment very difficult. The vestibular (buccal) surface strongly

resembles the labial surface of the canine but is slightly smaller. Curvature and angle characteristics are reversed. The medial ridge is displaced distally, the mesiobuccal cusp ridge is longer than the distal, and the mesial facet is larger than the distal. The cervical margin is curved apically, and cervical grooves are present. The lingual surface is smaller than the vestibular surface and more curved; the horizontal curvature is more pronounced and more rounded. The medial ridge and the lingual cusp are displaced mesially so that the distolingual cusp ridge appears longer. The cervical line is curved buccally. The approximal surface is almost rectangular. The contours of the buccal, lingual, and occlusal surfaces can be seen.

The occlusal surface (masticatory or chewing surface) has an oval outline and is wider buccally and rounded and narrower palatally. The horizontal curvature characteristic is reversed. The cusps are located on half of the buccal and lingual portions of the masticatory surface. The buccal cusp is larger, higher, and more angular, with prominent triangular ridges, cusp ridges, and crests, whereas the lingual cusp is rounded and looks more delicate. There may be displacement of the tip of the lingual cusp distally and the central developmental groove lingually.

The central developmental groove branches before the marginal ridges into two small supplemental developmental grooves running crosswise, giving the whole groove formation the appearance of a broad. Growth-related fossae are formed in the branching points of the central developmental groove; these are the deepest parts of the occlusal surface. The mesial approximal marginal ridge is concave for contact with the canine, whereas the distal ridge is convexly shaped. Growth-related depressions form on the triangular ridges, which can sometimes reach the same depth as a supplemental developmental groove.

Maxillary 1st premolar



Maxillary Second Premolar

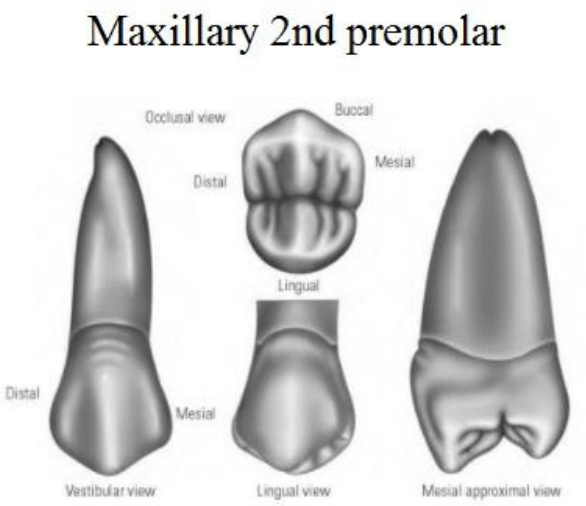
The maxillary second premolar may have a crown that is noticeably smaller cervico-occlusally and also mesiodistally; however, it may also be larger in those dimensions. Usually the root of the second premolar is as long as, if not a millimeter or so longer than, that of the first premolar. The two teeth have about the same dimensions on the average, except for the tendency toward greater length of the second premolar root.

The maxillary second premolar (dens praemolaris lateralis) is smaller, more compact, and more symmetric than the first premolar; the cusps are almost of the same height and virtually the same size, and the central developmental groove lies in the middle.

The second premolar is a rudimentary tooth. It has only a single developed root. The vestibular (buccal) surface is similar to that of the first premolar but smaller and without pronounced angle and curvature characteristics. The lingual surface is also similar to that of the first premolar, although the middle ridge lies centrally.

The approximal surface shows cusps of unequal height, the buccal cusp being more angular than the rounded lingual cusp. The central developmental groove lies in the middle and is very deep, which indicates a risk of caries.

Buccal and lingual curvatures are normal. The occlusal surface is more symmetric than on the first premolar but with the same characteristics: prominent buccal and rounded lingual cusps. The central development groove lies in the middle of the occlusal surface.



Mandibular Premolars

The main difference between the mandibular and maxillary premolars is that the mandibular ones have an almost circular crown outline. Furthermore, they are always single-rooted. Unlike the maxillary premolars, the mandibular first and second premolars differ considerably from each other.

The first premolar has a large buccal cusp, which is long and well formed, with a small, nonfunctioning lingual cusp that in some specimens is no longer than the cingulum found on some maxillary canines. The second premolar has three well-formed cusps in most

cases, one large buccal cusp and two smaller lingual cusps. The form of both mandibular premolars fails to conform to the implications of the term bicuspid, a term that implies two functioning cusps. The mandibular first premolar has many of the characteristics of a small canine, because its sharp buccal cusp is the only part of it occluding with maxillary teeth. It functions along with the mandibular canine. The mandibular second premolar has more of the characteristics of a small molar, because its lingual cusps are well developed, a fact that places both marginal ridges high and produces a more efficient occlusion with antagonists in the opposite jaw. The mandibular second molar functions by being supplementary to the mandibular first molar.

Mandibular First Premolar

The vestibular (buccal) surface of the first premolar is very similar to that of the mandibular canine. The first premolar is only slightly more compact, and the contact areas may be rather tapered. Overall the surface is highly convex. The ridge shaped cusp has a rounded tip, while the mesial cusp ridge is shorter than the distal (angle characteristic). One prominent central ridge divides the buccal surface again into two unequally sized facets with vertical depressions. The mesial contact area lies higher than the distal. In the cervical third, a short transverse and longitudinal convexity can be seen with poorly developed cervical grooves. The arched line of the cervix converges with concave, curved approximal margins. The curvature characteristic, like the angle characteristic, is well developed.

The lingual surface is very small and narrow and shows the very slightly developed lingual cusp. It tapers more cervically than buccally. The buccal cusp can be seen from the lingual aspect; only the central developmental groove is concealed by the small lingual cusp.This cusp has no opposing contact. As a result of the tooth inclination, the lingual cusp greatly overhangs the cervix; however, it is highly concave in the incisal third, so that a pronounced vertical curvature is visible. The approximal surface reveals both the large buccal and the small lingual cusps. The lingual bend in the crown axis corresponding to the tooth

inclination is most clearly visible approximally, as is the prominent longitudinal convexity—buccally in the cervical area and lingually in the occlusal. The approximal surfaces are prominent at the contact area and concave cervically.

The occlusal surface shows the circular outline of the crown. The lingual cusp is much smaller than the buccal and also more truncated. The occlusal surface is therefore markedly inclined toward the floor of the mouth. A sturdy cusp crest runs lingually from the buccal cusp; as a result, the central developmental groove is sometimes interrupted. The central developmental groove is markedly displaced lingually.

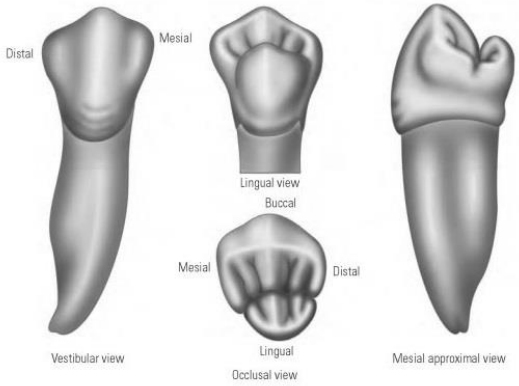
The approximal marginal ridges are sturdy and recede in a lingual direction. This produces two distinct fossae, with the mesial one being more superior. The distal marginal ridge also lies more inferiorly. There are three variations on the arrangement of the lingual cusp:

There is a very regular arrangement of the lingual cusp, where the line connecting the two cusps divides the tooth symmetrically.

The lingual cusp is small and rudimentary like a tubercle; there is only a suggestion of a central developmental groove.

The lingual cusp is displaced distally so that the crown takes on a triangular shape with the buccal cusp tip displaced mesially.

Mandibular 1st premolar



Mandibular Second Premolar

The mandibular second premolar resembles the mandibular first premolar from the buccal aspect only. Although the buccal cusp is not as pronounced, the mesiodistal measurement of the crown and its general outline are similar. The tooth is larger and has better development in other respects. This tooth assumes two common forms. The first form, which probably occurs most often, is the three-cusp type, which appears more angular from the occlusal aspect. The second form is the two-cusp type, which appears more rounded from the occlusal aspect. The single root of the second premolar is larger and longer than that of the first premolar. The root is seldom, if ever, bifurcated, although some specimens show a deep developmental groove buccally. Often a flattened area appears in this location

The mandibular second premolar is larger than the first premolar, but the resemblance is not as strong as that seen between the first and second premolar in the maxilla. The occlusal surface is more horizontal; there is only a slight difference in height between buccal and lingual cusps.

The tooth assumes two common forms. One has two cusps, and the other has three cusps, with one buccal and two lingual cusps. Very rarely there may be a four-cusp type with one buccal and three lingual cusps. The root of this tooth is roundish and, consistent with the stronger development of the second premolar, is longer and thicker than the root of the first premolar. The root is only bifurcated in rare cases.

The vestibular (buccal) surface resembles a compact, broad canine, with a ridge-shaped cusp ridge and rounded tip. The angle characteristic is pronounced so that the mesial angle lies slightly higher than the distal, as do the contact points. The formation of ridges and depressions is normal, and a curvature characteristic is present. The approximal margins are indented and taper down to the curved cervical margin.

The lingual surface is narrower and slightly shorter and has a pronounced transverse convexity. In the three-cusp type, the two lingual cusps are recognizable and make the surface appear divided. It is

noticeable that the distolingual cusp is smaller and lower than the mesial.

The surface also appears to overhang in the cervical area because of the tooth inclination and the strong vertical convexity. The buccal cusp can be seen in the lingual view because it rises above the lingual cusps.

The occlusal surface has all the features of a masticatory surface: cusps, cusp crests and ridges, marginal ridges, and grooves. The two-cusp type resembles the form of the maxillary second premolar. In the three-cusp type, the buccal cusp is the largest, while the linguodistal is the smallest.

The three cusps are formed by a large main developmental groove that diverges at a right angle from the central developmental groove: This main groove often originates in the middle or slightly more distally. As a result, the groove formation appears to create a Y-shape, which divides the three cusps. A third, very rare form is the four-cusp occlusal surface with three lingual cusps.

The approximal surface shows the crown-root angulation, ie, the lingual incline of the crown. In this view, the tooth inclination of the second premolar is also identifiable, but it is less developed than on the mesial neighbor.

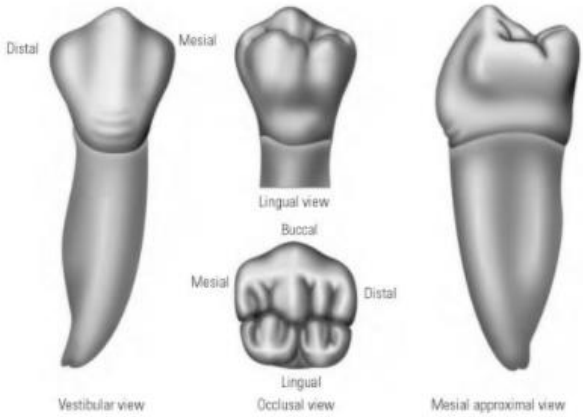
The vertical curvatures of the buccal and lingual surfaces can also be seen. The lingual contour overhangs in the occlusal area. The occlusal surface is only slightly tilted lingually. The buccal part of the occlusal surface is wider, so that the central developmental groove is displaced slightly lingually.

The approximal marginal ridge contains the contact point and tapers so that the approximal surface is concavely indented.

The occlusal characteristics of the two-cusp type are as follows:

1. The outline of the crown is rounded lingual to the buccal cusp ridges.
2. Some lingual convergence of mesial and distal sides occurs, although no more than is found in some variations of the square type.
3. The mesiolingual and distolingual line angles are rounded.
4. One well-developed lingual cusp is directly opposite the buccal cusp in a lingual direction.

Mandibular 2nd premolar



The maxillary molars differ in design from any of the teeth previously described. These teeth assist the mandibular molars in performing the major portion of the work in the mastication and comminution of food. They are the largest and strongest maxillary teeth, by virtue both of their bulk and of their anchorage in the jaws. Although the crowns on the molars may be somewhat shorter than those on the premolars, their dimensions are greater in every respect. The root portion may be no longer than that of the premolars, but instead of one root or a bifurcated root, the maxillary molar root is broader at the base in all directions and is trifurcated into three well-developed prongs that are actually three full-size roots emanating from a common broad base above the crown.

Generally speaking, the maxillary molars have large crowns with four well-formed cusps. They have three roots, two buccal and one lingual. The lingual root is the largest. The crowns have two buccal cusps and two lingual cusps. The outlines and curvatures of all the

maxillary molars are similar. Developmental variations will be set forth under descriptions of the separate molars.

Maxillary First Molar

The crown of this tooth is wider buccolingually than mesiodistally. Usually the extra dimension buccolingually is about 1 mm. This, however, varies in individuals. From the occlusal aspect, the inequality of the measurements in the two directions appears slight. Although the crown is relatively short, it is broad both mesiodistally and buccolingually, which gives the occlusal surface its generous dimensions.

The maxillary first molar is normally the largest tooth in the maxillary arch. It has four well-developed functioning cusps and one supplemental cusp of little practical use. The four large cusps of most physiological significance are the mesiobuccal, the distobuccal, the mesiolingual, and the distolingual.

A supplemental cusp is called the cusp or tubercle of Carabelli. This morphological trait can take the form of a well-developed fifth cusp, or it can grade down to a series of grooves, depressions, or pits on the mesial portion of the lingual surface. This trait has been used to distinguish populations. This supplemental cusp is found lingual to the mesiolingual cusp, which is the largest of the well-developed cusps. Usually, a developmental groove is found, leaving a record of cusp development, unless it has been erased by frictional wear. The fifth cusp or a developmental trace at its usual site serves to identify the maxillary first molar. A specimen of this tooth showing no trace of its typical characteristic would be rare.

The three roots of generous proportions are the mesiobuccal, distobuccal, and lingual. These roots are well separated and well developed, and their placement gives this tooth maximum anchorage against forces that would tend to unseat it. The roots have their greatest spread parallel to the line of greatest force brought to bear against the crown diagonally in a buccolingual direction. The lingual root is the longest root. It is tapered and smoothly rounded. The mesiobuccal root

is not as long, but it is broader buccolingually and shaped (in cross section) so that its resistance to torsion is greater than that of the lingual root. The distobuccal root is the smallest of the three and smoothly rounded.

The curvature characteristic clearly stands out. The vestibular and lingual surfaces converge distally to create the typical rhomboid shape of the maxillary first molar. The occlusal surface recedes distally. The maxillary first molars have three roots, two buccal and one palatal. The vestibular (buccal) surface gives the impression of being two premolars fused together because it is divided by a distinct longitudinal groove. The mesial and the distal portions of the surface have virtually the same form as a premolar. The occlusal border shows the ridge-shaped cusp form, with the mesial cusp higher and more pronounced than the rounded distal cusp. The medial ridges of the mesial and distal parts of the surface divide each of these into two facets. The mesial part of the surface is more bulging and prominent, while the distal part recedes posteriorly (curvature characteristic). The cervix curves in the middle in an occlusal direction. The cervical grooves are poorly developed.

The approximal surface has an almost rectangular shape. The typical vertical curvatures of the buccal and lingual surfaces can be seen. The buccal surface has its greatest curvature cervically, whereas occlusally it has a rather sloping and relatively sharp-edged course up to the cusps. The lingual surface bulges considerably so that the lingual cusps appear to be inclined toward the occlusal surface. The cusp tips on this tooth are also about half the tooth width apart. The mesial approximal surface is much larger (and particularly higher) than the distal; the mesial marginal ridge and hence the contact point are higher.The cervix curves evenly in an occlusal direction.

The lingual surface is smaller than the buccal surface, in keeping with the constriction caused by the dental arch. There is also some tapering toward the cervix.The longitudinal groove, which separates the two cusps, is displaced distally because the distopalatal cusp is generally only half the size of the mesial. The mesial cusp is again

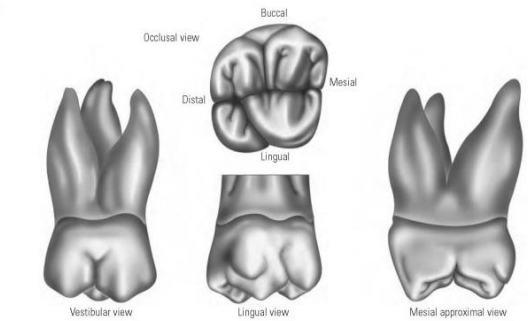
higher, more angular, and more noticeable. Both cusps, however, bulge inward toward the occlusal surface. The occlusal contour recedes distally. The cervical margin curves occlusally, as on the buccal surface.

The cusp of Carabelli (tuberculum anomale) is an additional, small, low-lying cusp on the mesial part of the lingual surface of the maxillary first molar.

The occlusal surface displays typical functional characteristics with four pronounced, differently sized cusps: two buccal shearing cusps and two palatal crushing cusps. Cusps in order of decreasing size are: mesiolingual, mesiobuccal, distobuccal, and distolingual.

The structure of the individual cusps reflects the described features. The buccal cusp ridge and crests are angular, whereas the lingual cusps appear rounded. The developmental grooves form small pits at their crossover points. Where the central developmental groove comes into contact with the buccal groove, the compact central fossa is formed. The supplemental grooves at the marginal ridges also form pronounced pits at the branching points with the central groove. The shape of the grooves produces a skewed. The marginal ridges in the approximal area are noticeable, while the mesial approximal edge is rather higher, almost straight, but the distal edge is curved outward.

Maxillary 1st molar



Maxillary Second Molar

The maxillary second molar (dens molaris laterali) has the same form as the first molar, with the only difference being that its lingual surface is less developed. The outline of the crown is often modified so that the rhomboid shape appears more acutely angled and the whole crown is far smaller than that of the maxillary first molar.

The cusp of Carabelli is absent, and the distolingual cusp is smaller, sometimes shrunken to a marginal ridge so that the occlusal surface has only three cusps. The three tooth roots are often fused.

Two types of maxillary second molars are found when the occlusal aspect is viewed: (1) The type that is seen most has an occlusal form that resembles that of the first molar, although the rhomboidal outline is more extreme. This is accentuated by the lesser measurement lingually. (2) The second type bears more resemblance to a typical third molar form. The distolingual cusp is poorly developed and makes the development of the other three cusps predominate. This results in a heart-shaped form from the occlusal aspect that is more typical of the maxillary third molar

The vestibular (buccal) surface is divided by a distinct longitudinal depression as in the maxillary first molar. The mesial cusp is higher and more pronounced than the rounded distal cusp, which recedes sharply. The mesial aspect of the surface is much more convex and prominent than the part that recedes distally. The cervical line bends occlusally in the middle. Cervical grooves are only poorly developed.

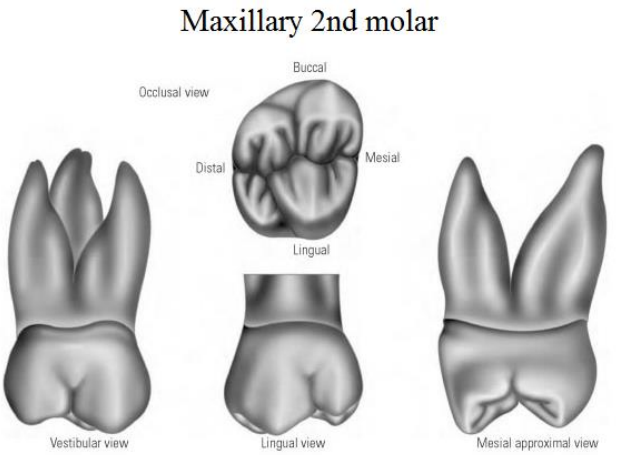
The lingual surface is much smaller than the buccal surface, tapering sharply to the cervix. The distolingual cusp may be rudimentary so that the occlusal contour sharply recedes distally. The mesial cusp is again higher, more sharp-edged, and more developed. There is rarely a cusp of Carabelli present.

The approximal surface has an almost rectangular shape. The typical vertical curvatures of the buccal and lingual surfaces can be seen. The mesial approximal surface is also much larger here than the

distal surface, with the mesial contact point located much higher. The cervical line bends occlusally.

The occlusal surface also displays typical functional characteristics, usually with four differently sized cusps: two buccal shearing cusps, one lingual crushing cusp, and one distolingual cusp shortened at the marginal ridge. The central developmental groove with the main buccal groove forms the central pit. The mesial approximal marginal ridge is more pronounced and higher, almost straight, while the distal margin curves outward again.

The rhomboidal type of second maxillary molar is most common, although in comparison with the first molar, the acute angles of the rhomboid are less and the obtuse angles greater. The buccolingual diameter of the crown is about equal, but the mesiodistal diameter is approximately 1 mm less. The mesiobuccal and mesiolingual cusps are just as large and well developed as in the first molar, but the distobuccal and distolingual cusps are smaller and less well developed. Usually, a calibration made of the crown at the greatest diameter buccally and lingually of the distal portion is considerably less than one made at the greatest diameter buccally and lingually of the mesial portion, so that more convergence distally is seen than in the maxillary first molar.



Maxillary Third Molar

The maxillary third molar often appears as a developmental anomaly. It can vary considerably in size, contour, and relative position to the other teeth. It is seldom as well developed as the maxillary second molar, to which it often bears resemblance. The third molar supplements the second molar in function, and its fundamental design is similar. The crown is smaller, and the roots are shorter as a rule, with the inclination toward fusion with the resultant anchorage of one tapered root.

The predominating third molar design, when the occlusal surface is viewed, is that of a heart-shaped type of second molar. The distolingual cusp is very small and poorly developed in most cases, and it may be absent entirely.

All third molars, mandibular and maxillary, show more variation in development than any of the other teeth in the mouth. Occasionally they appear as anomalies bearing little or no resemblance to neighboring teeth.

The mandibular molars are larger than any other mandibular teeth. They are three in number on each side of the mandible: the first, second, and third mandibular molars. They resemble each other in functional form, although comparison of one with another shows variations in the number of cusps and some variation in size, occlusal design, and the relative lengths and positions of the roots.

The crown outlines exhibit similarities of outline from all aspects, and each mandibular molar has two roots, one mesial and one distal. Third molars and some second molars may show a fusion of these roots. All mandibular molars have crowns that are roughly quadrilateral, being somewhat longer mesiodistally than buccolingually. Maxillary molar crowns have their widest measurement buccolingually.

The mandibular molars perform the major portion of the work of the lower jaw in mastication and in the comminution of food. They are

the largest and strongest mandibular teeth, both because of their bulk and because of their anchorage.

The crowns of the molars are shorter cervico-occlusally than those of the teeth anterior to them, but their dimensions are greater in every other respect. The root portions are not as long as those of some of the other mandibular teeth, but the combined measurements of the multiple roots, with their broad bifurcated root trunks, result in superior anchorage and greater efficiency.

Usually the sum of the mesiodistal measurements of mandibular molars is equal to or greater than the combined mesiodistal measurements of all the teeth anterior to the first molar and up to the median line.

Mandibular first molar

Normally, the mandibular first molar is the largest tooth in the mandibular arch. It has five well-developed cusps: two buccal, two lingual, and one distal. It has two well-developed roots, one mesial and one distal, which are very broad buccolingually. These roots are widely separated at the apices.

The dimension of the crown mesiodistally is greater by about 1 mm than the dimension buccolingually. Although the crown is relatively short cervico-occlusally, it has mesiodistal and buccolingual measurements that provide a broad occlusal form.

The mesial root is broad and curved distally, with mesial and distal fluting that provides the anchorage of two roots. The distal root is rounder, broad at the cervical portion, and pointed in a distal direction. The formation of these roots and their positions in the mandible serve to brace the crown of the tooth efficiently against the lines of force that might be brought to bear against it.

The vestibular (buccal) surface has the three ridge-shaped, rounded cusps that are divided by slight longitudinal grooves. The tooth recedes distally, in keeping with the angle characteristic. A pronounced longitudinal and transverse convexity can be seen in the cervical area, where there are also slight cervical grooves. The line of the cervix appears to be wavy. The distal contact point lies far more apically than

the mesial one, so that the mesial approximal edge has a greater longitudinal convexity than its distal counterpart.

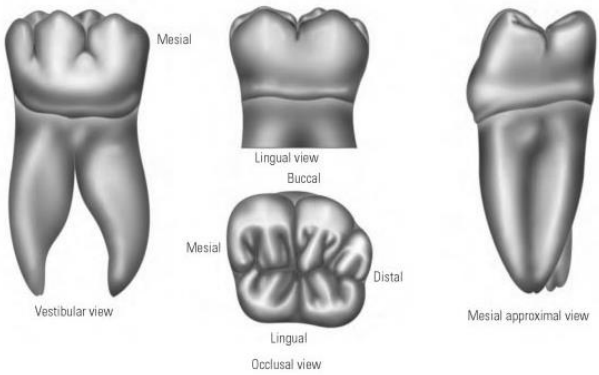
The lingual surface is divided by a longitudinal groove; it shows both of the rounded, ridgeshaped cusps. The markedly smaller surface has only a slight transverse and longitudinal convexity. The cervical line is located more coronally on the lingual side than on the buccal aspect and is undulating. The lingual surface is slightly overhanging because of the tooth inclination.

The approximal surfaces are rhomboid in keeping with the tooth inclination. The vertical curvature of the buccal surface is greatest cervically, whereas the lingual surface contour appears to be overhanging occlusally and displays no appreciable curvature. The buccal cusps are shorter and more rounded than the lingual ones. The distal approximal surface is considerably smaller. The contact points are overhanging.

The occlusal surface is almost rectangular but rounded and becomes narrower distally. It is made up of five differently sized cusps, in order of decreasing size: mesiolingual, mesiobuccal, dis-tolingual, centrobuccal, and distobuccal. The features of the cusps are typical, as is the pattern of the grooves.

The central developmental groove is divided medially by a distinct main developmental groove, which produces a cross. This is where the central pit is located. Distally another distinct main groove branches off buccally, which separates the distobuccal cusp. The central groove divides into pronounced supplemental grooves before reaching the approximal marginal ridges.

Mandibular 1st molar



Mandibular second molar

Normally, the second molar is smaller than the first molar by a fraction of a millimeter in all dimensions. It does not, however, run true to form. It is not uncommon to find mandibular second molar crowns somewhat larger than first molar crowns, and although the roots are not as well formed, they may be longer.

The crown has four well-developed cusps, two buccal and two lingual, of nearly equal development. Neither a distal nor a fifth cusp is evident, but the distobuccal cusp is larger than that found on the first molar.

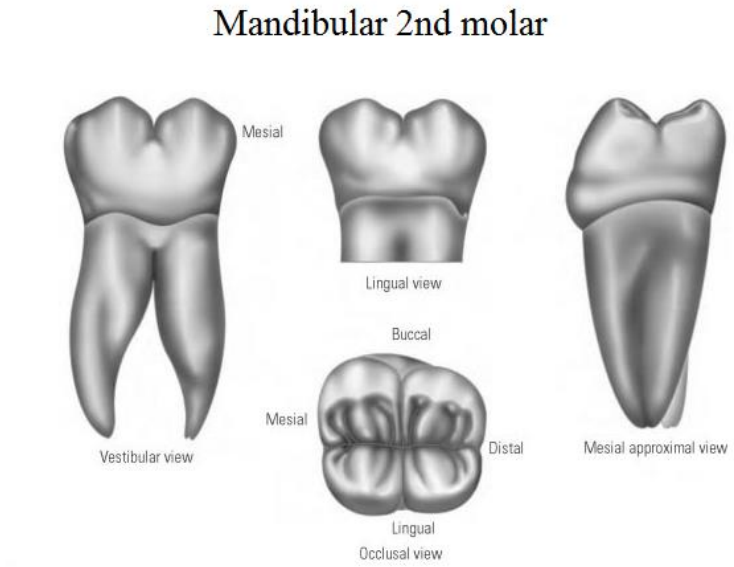
The tooth has two well-developed roots, one mesial and one distal. These roots are broad buccolingually, but they are not as broad as those of the first molar, nor are they as widely separated.

From the buccal aspect the crown is somewhat shorter cervico-occlusally and narrower mesiodistally than is the first molar

The occlusal aspect of the mandibular second molar differs considerably from that of the first molar. These variations serve as marks of identity.

The small distal cusp of the first molar is not present, and the distobuccal lobe development is just as pronounced, and sometimes more so, than that of the mesiobuccal lobe.

No distobuccal developmental groove is evident occlusally or buccally. The buccal and lingual developmental grooves meet the central developmental groove at right angles at the central pit on the occlusal surface. These grooves form a cross, dividing the occlusal portion of the crown into four nearly equal parts.



Mandibular Third Molar

The mandibular third molar varies considerably in different individuals and presents many anomalies both in form and in position. It supplements the second molar in function, although the tooth is seldom as well developed, with the average mandibular third molar showing irregular development of the crown portion, with undersized roots, more or less malformed. However, its design usually conforms to the general plan of all mandibular molars, matching more closely the second mandibular molar in the number of cusps and occlusal design than it does the mandibular first molar.

Occasionally, mandibular third molars are seen that are well formed and comparable in size and development to the mandibular first molar. Many instances of mandibular third molars with five or more cusps are found, with the crown portions larger than those of the second molar. In these cases, the alignment and occlusion with other teeth is not normal, because insufficient room is available in the alveolar process of the mandible for the accommodation of such a large tooth, and the occlusal form is too variable.

Topic 3. Instruments for restorations. Rubber dam in dentistry. Principles of isolation of the working field. Methods of applying rubber dam during the restoration of various groups of teeth. Selection of clasps. Methods of retraction.

Equipment needed for isolation

Different equipment and materials can be used for making isolation of operating field. These can be divided into following groups:

• Tissue retractors and protecting devices:

– Best tissue retractor and protector is rubber dam.

– Cheek and lip retractors are used to pull both lips and cheek backwards and outwards.

– Tongue depressors help in depressing the tongue during procedures.

– Metallic band can also be used to protect the adjacent tooth while class II tooth preparation.

• Equipment used for evacuation of fluids and debris:

– Saliva ejectors/low volume ejectors are used to remove saliva and water coming from air rotor while working.

– High volume evacuators: these are attached to high volume suction unit.

• Fluid absorbing materials: These materials are used to absorb salivary secretion. They can be:

– Absorbent paper pads or wafers.

– Cotton rolls.

– Gauze pieces.

Rubber dam can be defined as a flat thin sheet of latex/ nonlatex that is held by a clamp and frame which is perforated to allow the tooth/teeth to protrude through the perforations while all other teeth are covered and protected by sheet.

Rubber dam eliminates saliva from the operating site, retracts the soft tissue and defines the operating field by isolation of one or more teeth from the oral environment.

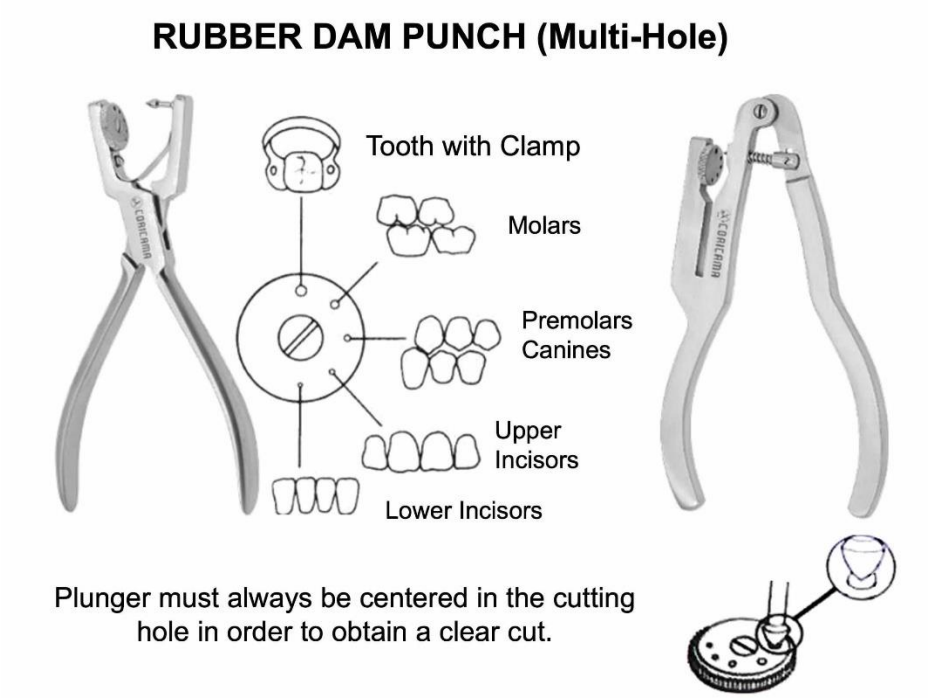
Rubber Dam Equipment

• Rubber dam sheet.
• Rubber dam clamps.
• Rubber dam forceps.
• Rubber dam frame.

• Rubber dam punch.

Rubber Dam Accessories

• Lubricant/petroleum jelly.
• Dental floss.
• Rubber dam napkin.

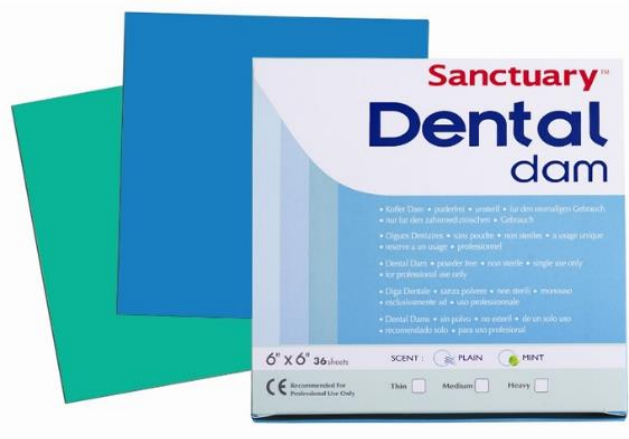


Rubber Dam Sheet

• Rubber dam sheet is available in size 6'' × 6'' squares and colors are usually green, blue or black .
• Sheet has dull and shiny side. Dull side is placed facing the operator because it is less reflective.
It is available in three thicknesses, i.e. light, medium and heavy. Middle grade is usually preferred as thin is more prone to tearing and thickest more difficult to apply.
• Thicker dam is effective in retracting the tissues and is more resistant to tearing. It is indicated for isolation of class V lesions.

• Thinner dam can pass through the contacts easier. It is indicated in teeth with tight contacts.
• Latex-free dam is necessary as number of patients are increasing with latex allergy. Flexi dam is latex-free dam of standard thickness with no rubber smell.

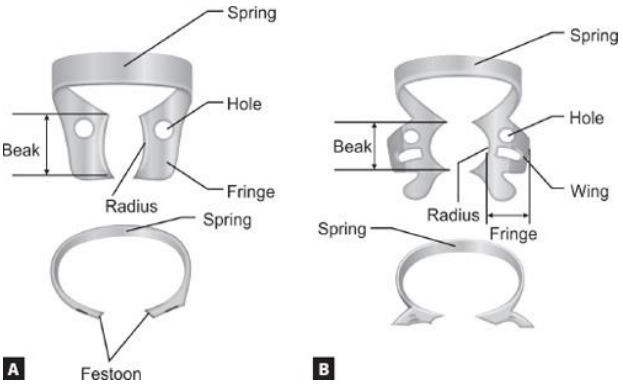
Rubber dam sheet

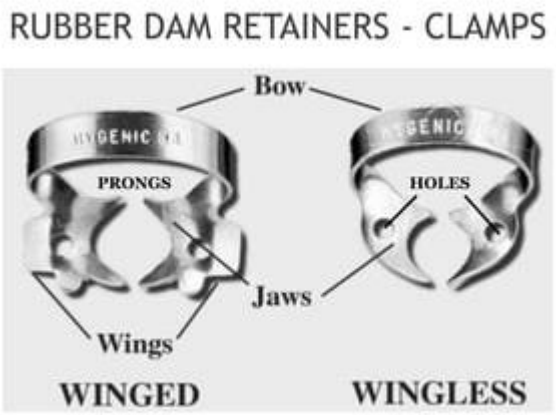


Rubber Dam Clamps/Retainer Rubber dam clamps, to hold the rubber dam on to the tooth are available in different shapes and sizes.
Clamps mainly serve two functions:
• They anchor the rubber dam to the tooth.

• Help in retracting the gingivae.

Clamps





Classification of clamps on the basis of jaw design:

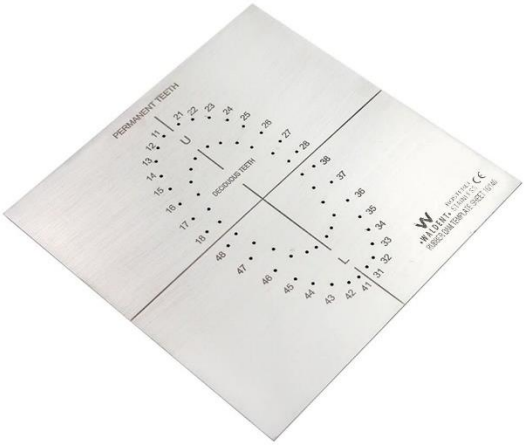
1. Bland
2. Retentive.

Bland clamps: bland clamps are usually identified by the jaws, which are flat and point directly towards each other. In these clamps,

flat jaws usually grasp the tooth at or above the gingival margin. They can be used in fully erupted tooth where cervical constriction prevents clamp from slipping off the tooth.

Retentive clasps: as the name indicates, these clasps provide retention by providing four-point contact with the tooth. In these, jaws are usually narrow, curved and slightly inverted which displace the gingivae and contact the tooth below the maximum diameter of crown.

Rubber Dam Template Sheet



Methods of Rubber Dam Placement

Method I—clamp placed before rubber dam:

- Select an appropriate clamp according to the tooth size.
- Tie a floss to clamp bow and place clamp onto the tooth.
- Larger holes are required in this technique as rubber dam has to be stretched over the clamp. Usually two or three overlapping holes are made.

Stretching of the rubber dam over the clamps can be done in the following sequence:

– Stretch the rubber dam sheet over the clamp.
– Then stretch the sheet over the buccal jaw and allow to settle into place beneath that jaw.
– Finally, the sheet is carried to palatal/lingual side and released. This method is mainly used in posterior teeth in both adults and children except third molar.
Method II—placement of rubber dam and clamp together:

• Select an appropriate clamp according to tooth anatomy.
• Tie a floss around the clamp and check the stability.
• Punch the hole in rubber dam sheet.
• Clamp is held with clamp forceps and its wings are inserted into punched hole.
• Both clamp and rubber dam are carried to the oral cavity and clamp is tensed to stretch the hole.
• After seating the clamp, again check stability of clamp.
• Remove the forceps from the clamp.
• Now, release the rubber sheet from wings to lie around the cervical margin of the tooth.
Method III—split dam technique:

This method is split dam technique in which rubber dam is placed to isolate the tooth without the use of rubber dam clamp. In this technique, two overlapping holes are punched in the dam. The dam is stretched over the tooth to be treated and over the adjacent tooth on each side. Edge of rubber dam is carefully teased through the contacts of distal side of adjacent teeth.
Indications of split dam technique:

• To isolate anterior teeth.
• When there is insufficient crown structure.
• When isolation of teeth with porcelain crown is required. In such cases placement of rubber dam clamp over the crown margins can damage the cervical porcelain.

Removal of Rubber Dam

Before the rubber dam is removed, use the water syringe and high volume evacuator to flush out all debris that collected during the

procedure. Cut away tied thread from the neck of the teeth. Stretch the rubber dam facially and pull the septal rubber away from the gingival tissue and the tooth. Protect the underlying soft tissue by placing a fingertip beneath the septum. Free the dam from the interproximal space, but leave the rubber dam over the anterior and posterior anchor teeth.

Use clamp forceps to remove the clamp. Once retainer is removed, release the dam from the anchor tooth and remove the dam and frame simultaneously. Wipe the patient's mouth, lips, and chin with a tissue or gauze to prevent saliva from getting on the patient's face. Check for any missing fragment after procedure. If a fragment of the rubber dam is found missing, inspect interproximal area because pieces of the rubber dam left under the free gingival can result in gingival irritation.

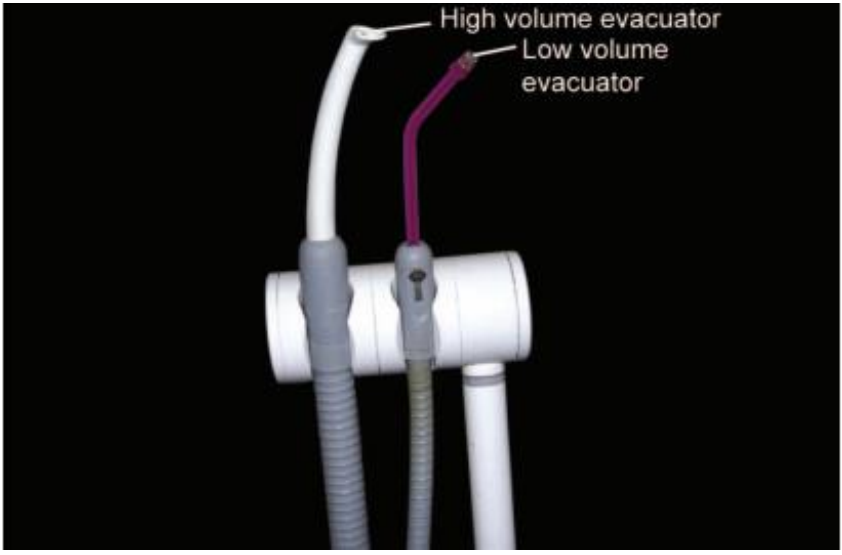
Absorbents (Cotton Roll and Cellulose Wafers)

Cotton rolls, pellets, gauze, and cellulose wafers absorbents are helpful for short period of isolation, for example, in examination, polishing, pit and fissure sealant placement. Absorbents play an essential role in isolation of the teeth especially when rubber dam application is not possible. Cotton rolls are usually placed in buccal or lingual sulcus specially where salivary gland ducts exit so as to absorb saliva.

Low-Volume Evacuator. Low volume evacuation is basically done using saliva ejectors. Saliva ejector is best used to remove small amounts of moisture and saliva collected in the oral cavity during clinical procedure. It can be used in conjunction with other methods of moisture control.

Tip of saliva ejector should be smooth to prevent any tissue injury. It is better to have small diameter disposable tip. To avoid any interference with working, it can be bent to place in the required area of mouth. Saliva ejector with flexible plastic tubing and protective flange provides an added advantage of retraction of tongue.

High-Volume Evacuator. It is used to remove water from airotor and large particulate matter with high suction speed. It is best performed by double-ended aspiration tip. One aspiration tip is kept on lingual side and another on the buccal side so as to aspirate from both sides. It also helps in retracting cheek and tongue. Tip used in high volume evacuator can be made-up of plastic or stainless steel.



Air-Water Syringe. By air-water syringe an air blast can be useful to dry tooth or soft tissues during examination or used during operative procedures.

Methods used for gingival tissue management

There are various methods available which can be used for effective gingival tissue retraction.

These methods are:

• Physicomechanical.
• Chemical.
• Chemomechanical.
• Rotary curettage.
• Electrochemical.
• Surgical.

Mechanical gingival retraction techniques involve physically pushing the gingival tissues away from the prepared tooth surface. This is typically done using cord-based materials, which can be impregnated with astringent chemicals that help to control bleeding and inflammation. These cords are placed in the gingival sulcus surrounding the prepared tooth and then gently pulled to displace the tissue. The cord is left inplace for several minutes to allow the tissue to be displaced and to give time for the astringent chemicals to take effect. After removal of the

cord, the gingival tissue will remain retracted for a short period of time, allowing for easy access to the prepared tooth surface for impression taking.

Chemical gingival etraction techniques involve the use of chemicals to achieve gingival retraction. These chemicals cause the gingival tissue to shrink, creating space for impression material. Chemicals used for this purpose include aluminum chloride, ferric sulfate, and potassium aluminum sulfate. These chemicals are usually applied to the gingival tissue using a syringe or a cotton pellet.

Surgical gingival retraction involves the use of a scalpel or laser to create an incision in the gingival tissue. This technique is less commonly used due to the risk of bleeding and post-operative pain. However, it can be useful in cases where other techniques have failed.

Less invasive techniques have been developed to reduce the discomfort associated with traditional cord-based methods.

For example, Expasyl, a paste-like material containing aluminum chloride, has been shown to produce moderate gingival displacement.

Another cordless technique, Magic Foam cord, is based on a polyvinyl siloxane material and is designed for quick and easy retraction of the gingiva. Merocel, a synthetic material in strip form, works by absorbing gingival fluids and mechanically displacing the gingiva.

In addition, diode lasers have been used for periodontal and implant surgeries, with the advantages of easy application, patient comfort, and good hemorrhage control The success of gingival retraction largely depends on the clinician's ability to select the most appropriate technique for each individual case, taking into consideration factors such as the location of the tooth, the condition of the gingival tissue, and the type of impression material being used.

In recent years, cordless gingival retraction techniques have gained popularity due to their ease of use and decreased patient discomfort compared to traditional cord packing techniques. The use of chemical agents such as aluminum chloride and ferric sulfate

have also been widely studied, with promising results in achieving adequate gingival displacement.

Magic FoamCord Intro Kit *Retraction cord*
Gingiva Retraction

Retraction paste

Composite Placement Instruments

Used for Composite Insertion:

Hand instruments: hand instruments used for placing composites are usually made up of coating with Teflon so as to avoid sticking of composite to the instrument.

Composite gun: composite gun is made up of plastic. It is commonly used with composite filled ampules. For use composite

compules are fitted in the gun and the pressure is applied so that composite comes out from the ampule.

Syringe: composite syringe usually carries the low viscosity composite which can easily flow through needle. This technique has advantage of providing an easy way for placement of composite with decreased chances of air trapping. Irrespective of location of restoration, composites should be placed and polymerized in increments.

This ensures complete polymerization of the whole composite mass and aids in the anatomical build-up of the restoration. Each increment should not be more than 2 mm in thickness, because it is difficult to cure and results in more polymerization shrinkage stress.

Filling instruments

Composite gun

Composite syringe

Topic 4. Modern materials for aesthetic dental restoration. Auxiliary materials. Selection of composite material and its shades during dental restoration. The concept of polychrome restoration.

A tooth, as a colored entity, does not only absorb and reflect light, but also refracts, diffracts, transmits, scatters, and creates unique light optically.

Some of the optical phenomena that relate to light include:

• Direct transmission: when light passes freely and finds no obstacle.
• Diffuse transmission: when light takes many directions after hitting the object.
• Selective transmission: when only certain wavelengths can pass.
• Reflection: when light is rejected.
• Refraction: when light travels at a different direction and speed when incorporated into another vehicle.
• Diffraction: when light stops traveling in straight lines and creates self-interference with the beams that have followed this path.

Artistic elements related to dentistry.

In conservative esthetic dentistry, these elements include the following :

• Shape or form.
• Symmetry and proportionality.
• Position and alignment.
• Surface texture.
• Color.
• Transparency and translucency.
• Opalescence.

Some or all of these elements affect every conservative esthetic dental procedure, but the ones that relate to shade selection are mostly the last three ones.

The color of teeth varies with the translucency, thickness, and distribution of enamel and dentin and the age of the patient. Other factors such as fluorosis, tetracycline staining, and endodontic treatment also affect tooth color. Because of those many variables, it is necessary to match the individual surface of the tooth to be restored.

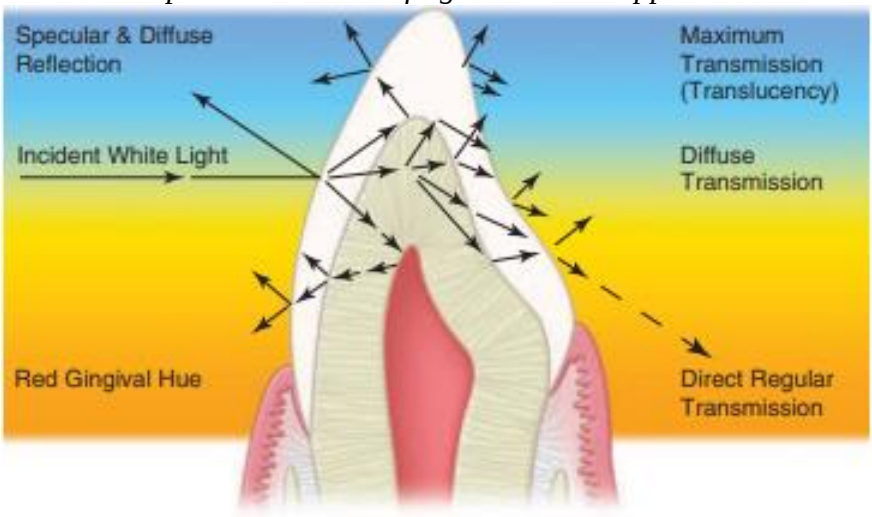
According to tooth tissues, five color shades form a natural extensive chromatic range:

• Yellow/Orange: dentin.
• White: enamel and internal enamel characteristics.
• Blue: free enamel opalescence.
• Amber: opalescence, counter-opalescence, and various enamel and dentin characteristics.

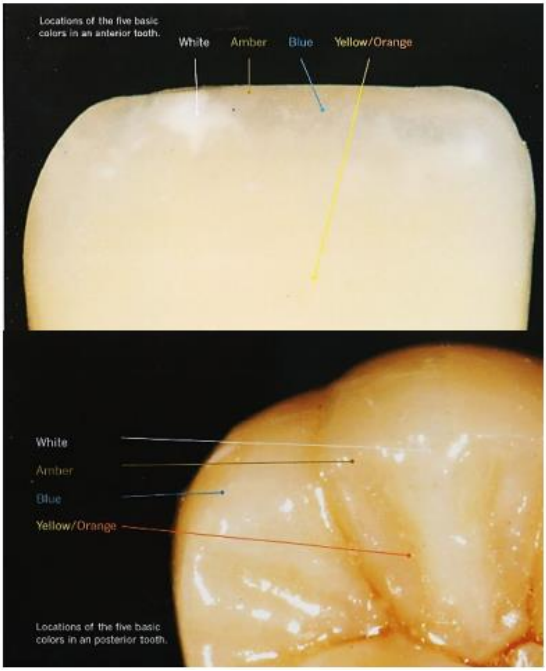
According to the location, four colors offer features and optical properties common to most teeth:

• Yellow/Orange: cervical and middle thirds.
• White: mammelons, incisal halo, occlusal and facial surfaces.
• Blue: incisal edge and proximal surfaces.
Amber: incisal halo, incisal edge, and facial surfaces (characteristics).

Complex interactions of light and tooth appearance.



Different colors of teeth surfaces in anterior and posterior teeth



The incisal halo: distinct line of opalescent relection at incisal edge.

Current shade selection tools are divided into three main groups as the following:

· VITA classical shade guide.
· VITA System 3D-Master shade guide.
· Other shade selection devices.

All of them can be used in any dental procedure that requires shade selection, such as composite restorations, crown and bridge, veneer, complete and removable dentures, and dental implants.

VITA classical shade guide

The VITA classical (A1–D4) was a gold standard for shade selection in dentistry for decades and to a large extent it still is. The majority of resin composites, dental ceramics, and denture teeth are keyed to this shade guide. VITA classical shade guide contains 16 shade tabs.

The original tab division is known as the "A to D" arrangement, with four groups created based on hue: A is reddish-brown (A1, A2, A3, A3.5, A4), B is reddish-yellow (B1, B2, B3, B4), C is gray (C1, C2, C3, C4), and D is reddish- gray (D2, D3, D4).

The older preserved shade guide, the Vita Lumin Vacuum guide (Vident), has existed since 1956, it was made from porcelain which affected the visual properties of the shades, but recent versions are made up from composite to not compromise the validity of shade selection procedure.

A, Vita classical shade guide: A–D arrangement. B, "Value Scale" arrangement of same shade guide.

VITA System 3D-Master shade guide.

It is another shade guide that divided into numbers (1, 2, 3, 4, and 5) in front of the letters representing the group number and lightness level; a lower number indicates a higher lightness. The more chromatic tabs are indicated by larger numbers.

The major difference between the Vita Classical and Vita 3D-Master shade guides is that the Vita Classical shade guide is built on the color hue and the Vita 3D-Master is built upon the color value. The Vita 3D-Master shade guide is considered superior to the Vita classical shade guide.

One of the other advantages of VITA 3D-Master is the repeatability of shade selection with the system. It was concluded that the use of this system compared with the classic guide improved intra-rater repeatability among dental practitioners.

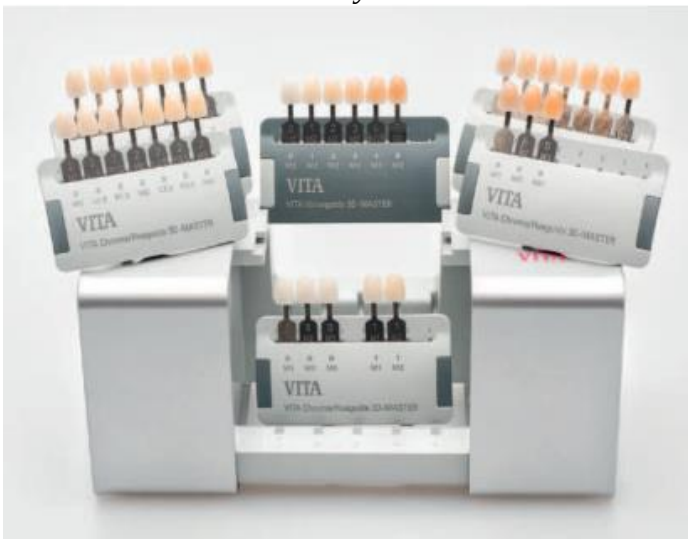
There are three major types of this shade guide:

A. Tooth guide: it has 11 sets of teeth, which consist of 26 samples ranging from lightest to darkest value, from lowest to the highest intensity and from yellow to red.

B. Linear guide: it enables the quick determination of precise tooth shades using the same principles of the VITA 3D-Master guide, the only difference is that it is sleeker and in a linear design.

C. Bleached guide: it is a modified design with the introduction of 6 groups in it. No. 0 for the shade matching of bleached teeth which has the (0M1, 0M2,0M3) shades, with more lightness, three levels of chroma and a middle hue. (

Vita Linearguide 3D-Master. Primary division into groups is made according to value (0–5); within the groups the chroma (1 = least; 3 = most) and hue (M = "neutral" middle hue; L = less red; R = more red) vary.



Other shade selection devices

These devices have been designed to aid clinicians and technicians in the specification and control of tooth color. They are mainly composed of a detector, signal conditioner and software that

processes the signal in a manner that makes the data usable in the dental operatory or laboratory.

Some examples of those devices include:

- Dental colorimeter.
- Dental spectrophotometer.
- Spectro Shade device.
- Digital cameras.

Dental spectrophotometer

Guidelines for Initial Shade Selection

• Teeth and shade guide should be wet to simulate oral environment.
• Shade matching should be carried in natural daylight.
• Dentin shade is selected from cervical third of tooth, and enamel shade is selected from its incisal third.
• To confirm final shade, a small increment of selected composite is placed adjacent to the area to be restored and then light cured for matching.

Classification of composite filling (restorative) materials

• According to Skinner:

– Traditional or conventional composite—8–12 µm.
– Small particle filled composites—1–5 µm.
– Microfilled composites—0.04–0.4 µm.
– Hybrid composites—0.6–1 µm.

• Philips and Lutz classification according to filler particle size:
– Macrofiller composites (particles from 0.1-100 μ).
– Microfiller composites (0.04 μ particles).
– Hybrid composites (fillers of different sizes).
• According to the mean particles size of the major fillers:
– Traditional composite resins.
– Hybrid composite resins.
– Homogeneous microfilled composites—if the composite simply consists of fillers and uncured matrix material, it is classified as homogeneous.
– Heterogeneous microfilled composites—if it includes procured composites and other unusual filler, it is called as heterogeneous.
• Classification according to Bayne and Heyman
– Megafill 1-2 mm.
– Macrofill 10-100 μm.
– Midifill 1-10 μm.
– Minifill 0.1-1 μm.
– Microfill 0.01-0.1 μm.
– Nanofill 0.005-0.01 μm.
• Classification according to matrix compositions
– Bis-GMA.
– UDMA.
• Classification according to polymerization method
– Self-curing.
– Light curing - ultraviolet light curing/ visible light curing.
– Dual curing.
– Staged curing.

Macrofilled composites

The macrofiled composites contain particles of an inorganic filler of large size (8 - 45 mm, sometimes about 100 um).

The advantages of macrofilled composites:

- sufficient strength;
- acceptable optical properties;
- radioopacity.

However, over the long term of clinical use some disadvantages of this group of composites have been found:

- polishing difficulties;
- high roughness of the surface;
- accumulation of dental plaque;
- bad colour stability.

The indications for the use of macrofilled composites:

- filling of the I class cavities;
- filling of the V class cavities in the masticatory teeth;
- filling of the front teeth cavities it the aesthetic effect is not a priority (for example, carious cavity localization on the tongue surface);
- restoration of badly damaged crowns of the front teeth with subsequent restoration of the vestibular surface with microfilled materials;
- filling the II class cavities in the premolars in the molars they are a material of choice);
- modelling tooth stumps to be used under crowns (Coradent (Vivadent), Rebilda (Voco)).

Microfilled composites

The high aesthetic requirements for filling materials led to creation of microfilled composites. As fillers there are used very small particles with a size of 0.04 - 0.4 um, typically silicon dioxide. The advantages of microfilled composites:

- good grindability;
- stability of glossy surface;
- high colour stability;
- satisfactory aesthetic quality;

At the same time, microfilled composites have such drawbacks:

- insufficient mechanical strength;
- a high coefficient of thermal expansion.

The indications for the use of microfilled composites:

- filling of the Ill class cavities;
- filling of the V class cavities;
- filling of the defects in non-carious teeth lesions (enamel erosion, hypoplasia, wedge-shaped defects etc.);
- aesthetic filling of the IV class cavities and traumatic injury of the

crown (in combination with hybrid or macrofilled composites and pulp pins).

Minifilled composites

The filler particles usually have a size of 15 um. They occupy an intermediate position between the micro- and macrofilled composites. These materials have satisfactory aesthetic and physic- mechanical properties; they are used for the restoration of the masticatory (small cavities) and front teeth. However, due to the lack of durability and colour stability they are not very common in dental practice.

Hybrid composite

Resins Hybrid composites are named so because they are made up of polymer groups (organic phase) reinforced by an inorganic phase. Hybrid composites are composed of glasses of different compositions and sizes, with particle size diameter of less than 2 μm and containing 0.04 μm sized fumed silica. Filler content in these composites is 75 to 80% by weight. This mixture of fillers is responsible for their physical properties similar to those of conventional composites with the advantage of smooth surface texture.

Advantages

• Availability in various colors.
• Different degrees of opaqueness and translucency in different tones and fluorescence.
• Excellent polishing and texturing properties.
• Good abrasion and wear resistance.
• Similar coefficient of thermal expansion.
• Ability to imitate the tooth structure.
• Decreased polymerization shrinkage.
• Less water absorption.

Disadvantages

• Not appropriate for heavy stress bearing areas
• Not highly polishable as microfilled because of presence of larger filler particles in between smaller ones
• Loss of gloss occurs when exposed to toothbrushing with abrasive toothpaste.

Two new generations of hybrid composite resins are:

1. Nanofill and nanohybrids
2. Microhybrids.

Flowable Composite

Filler content is 60% by weight with particle size ranging from 0.02 to 0.05 μm. Low filler loading is responsible for decreased viscosity of composites, which allows them to be injected into small preparations, this makes them a good choice for pit and fissure restorations. But incorporation of lower filler content results in poor mechanical properties of these composites than conventional composites.

Indications

• Preventive resin restorations.
• Small pit and fissure sealants.
• Small, angular Class V lesions.
• For repairing ditched amalgam margins.
• Repair of small porcelain fractures.
• Inner layer for Class II posterior composite resin placement for sealing the gingival margin.
• Resurfacing of worn composite or glass ionomer cement restorations.
• For repair of enamel defects.
• For repair of crown margins.
• Repair of composite resin margins.
• For luting porcelain and composite resin veneers.
• Class I restorations.
• Small Class III restorations.
• As base or liner.
• Tunnel restorations.

Contraindications

- High stress areas like class I and II cavities because of low strength and more wear.

Condensable (Packable) Composites

Condensable/packable composites have improved mechanical properties and handling characteristics. Main basis of packable composites is Polymer Rigid Inorganic Matrix Material (PRIMM). Here components are resin and ceramic inorganic fillers which are incorporated in silanated network of ceramic fibers. These fibers are composed of alumina and silicon dioxide which are fused to each other at specific sites to form a continuous network of small compartments. Filler content in packable composites ranges from 48 to 65% by volume with average particle size ranging from 0.7 to 20 μm.

Properties of packable composites:

- Packable composites posses improved mechanical properties because of presence of ceramic fibers.
- Improved handling properties because of presence of higher percentage of irregular or porous filler, fibrous filler and resin matrix.
- Consistency of condensable composites is like freshly triturated amalgam, so it can be pushed into posterior tooth preparation and has greater control over proximal contour of Class II preparations.
- High depth of cure due to light conducting properties of ceramic fibers. Each increment of composite can be condensed like amalgam and cured to a depth of over 4 mm.
- Low polymerization shrinkage.

Indications

- Indicated for stress-bearing areas.
- In Class II restorations as they allow easier establishment of physiological contact points.

Compomers (Polyacid Modified Composite Resins)

Compomers provide combined advantages of composites (term ‘Comp’ in their name) and glass ionomer (‘Omers’ in their name). They are available in single paste, light enable material in syringe or compules.

Light curing of resin composites is initiated by light in the wavelength range 450–500 nm. This blue light can damage the eyes so an orange filter should be used when the light is in use. The tip of the

light source should be placed as close as possible to the surface of the restoration and each increment of composite should be cured for 40–60 seconds. Under-cured composites will readily absorb stain and will rapidly degenerate.

Polymerization shrinkage of the resin during curing (in the order of 2–3%) still occurs and may contribute to marginal defects, cuspal distortion and crack formation in the enamel or dentine, and may therefore contribute to postoperative pain or sensitivity for the patient. There are, however, a number of clinical techniques available to overcome these problems and the longevity of restorations using the newer resin composites is much improved over that of the original materials.

Reducing the effect of polymerization shrinkage may be achieved by incremental packing of the composite. Each increment should touch as few walls of the cavity as possible. The stress induced by polymerization shrinkage is highest in cavities with more bonded than unbonded surfaces: the occlusal cavity has the potential for the most stress.

Setting mechanisms of resin composite

Types of setting mechanisms:

- Chemical cure (self-cure / dark cure).
- Light cure.
- Dual cure (setting both chemically and by light).

• Chemically cured resin composite is a two-paste system (base and catalyst) which starts to set when the base and the catalyst are mixed together.
• Light cured resin composites contains a photo-initiator (e.g. camphorquinone) and an accelerator. The activator present in light activated composite is diethyl-amino-ethyl-methacrylate (amine) or diketone. They interact when exposed to light at wave length of 400-500 nm, i.e, blue region of the visible light spectrum. The composite sets when it is exposed to light energy at a set wave length of light. Light cured resin composites are also sensitive to ambient light, and therefore, polymerization can begin before use of the curing light.
• Dual cured resin composite contains both photo-initiators and chemical accelerators, allowing the material to set even where there is insufficient light exposure for light curing.
• Chemical polymerization inhibitors (e.g. monomethyl ether of hydroquinone) are added to the resin composite to prevent polymerization of the material during storage, increasing its shelf life.

Curing Lamps Different types of lights used in curing are:

• Tungsten-quartz halogen (TQH) curing unit.
• Plasma arc curing (PAC) unit.
• Light emitting diode (LED) unit.
• Argon laser curing unit.

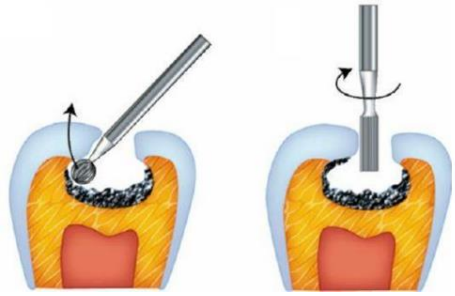
Topic 5. Principles of preparation of various cavities according to Black to ensure the aesthetic result of artistic restoration. Methods of processing the prepared cavity.

Regardless of which group the tooth belongs to and on which surface there is a carious cavity, the preparation consists of a number of mandatory and sequential stages:

1) Opening of a carious cavity.
2) Widening of a carious cavity
3) Necrectomy (excision of non-viable tissues).
4) Cavity formation.
5) Shaping of the enamel edges of the carious cavity.

Opening and widening of carious cavity

The size of the carious cavity is much larger than the size of the inlet, especially in acute caries. The opening of the carious cavity involves the removal of overhanging edges of the enamel, providing free access, visual control of the cavity and performing the following stages of preparation. In case of insufficient opening of the cavity, the overhanging edges break off, which can lead to the development of secondary caries, violation of the anatomical shape of the tooth or loss of filling.



Round (spherical) or fissure burs are used to open the carious cavity, they are selected so that the size of the working part was not larger than the inlet of the carious cavity. During the opening of the

carious cavity located on the chewing surface, the spherical boron is brought under the overhanging edges of the enamel. Turn on the drill and with careful movements, as if putting a coma, removing boron from the carious cavity, remove the overhanging edges of the enamel.

Necrectomy

This is the final removal from the carious cavity of all non-viable hard tissues (mainly dentin) and their decay products. The amount of necrectomy is determined by the nature of the clinical course of caries, the location and depth of the carious cavity. It is carried out with the help of excavators and ball drills.

Manipulation begins with a sharp excavator, selected according to the size of the carious cavity. In shallow and medium depth cavities, dentin can be excavated, starting from each of the walls of the carious cavity, in turn.

The sharp edge of the working part of the excavator is deepened into the softened dentin and the dentin layer is removed with lever-like movements. In mantle dentin the fibers of the main substance are located radially, so the excavator should be deepened towards the tooth axis, in pulpal dentin the fibers are located tangentially, so the excavator should be deepened in the transverse direction.

Necrectomy, especially of the deep cavity, should be performed carefully so as not to open the tooth cavity and injure the

pulp. Removal of infected but denser dentin is continued with a drill using spherical, fissure and conical burs.

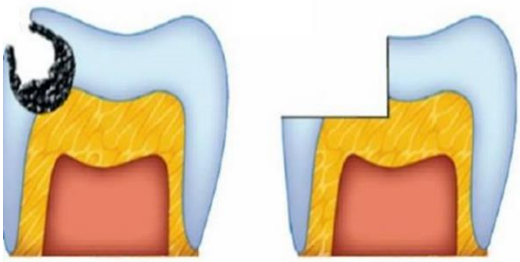
Cavity formation

It is a very important stage of preparation, its purpose is to create a shape of the cavity that would be able to hold the filling material for a long time and keep the seal. To do this, it must meet certain requirements.

The walls and bottom of the prepared carious cavity should be located (one plane relative to the other) at 90 angles, have smooth, not rough, surfaces.

The bottom of the cavity, as a rule, should be flat or repeat the shape of the chewing surface of the tooth.

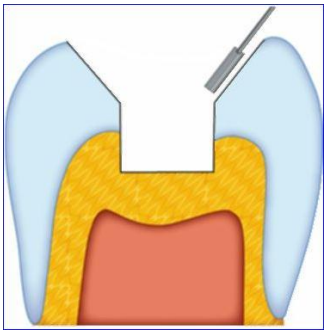
It is necessary that the angles between the walls and the bottom were straight and well defined, because in them filling material will fix.



A rectangle is the most convenient shape for holding a seal, but oval, triangular, cross-shaped, and cylindrical cavities are possible. For better fixation of the seal, it is sometimes recommended to create retention points on the walls of the cavity in the form of grooves, recesses, cuts. Fissure, inverted-conical, cone-shaped and wheel-shaped burs are used to form a carious cavity.

Finishing the enamel edges

Is the last stage of cavity formation. At the same time it is necessary to pay attention that external parts of enamel prisms had good support in the dentin which is contained below. Otherwise, the overhanging edges of the enamel, deprived of nutrition and support, will not be able to withstand the masticatory pressure and will break off. This can lead to the appearance of a retention point, recurrence of caries and destruction or loss of the seal. Therefore, finishes and carborundum heads are carefully (because the enamel is quite fragile and can break off) to process the enamel edge, cutting off overhanging areas. Thus, the enamel edge must be formed in accordance with the direction of the enamel prisms. Depending on the type of filling material to be used in the future, it is necessary to mow the enamel edge at an angle of 45 ° or round it.



To achieve this goal during the preparation of a carious cavity, it is necessary:

1. In each case, identify the elements of the carious cavity and ensure its reliable visual control.

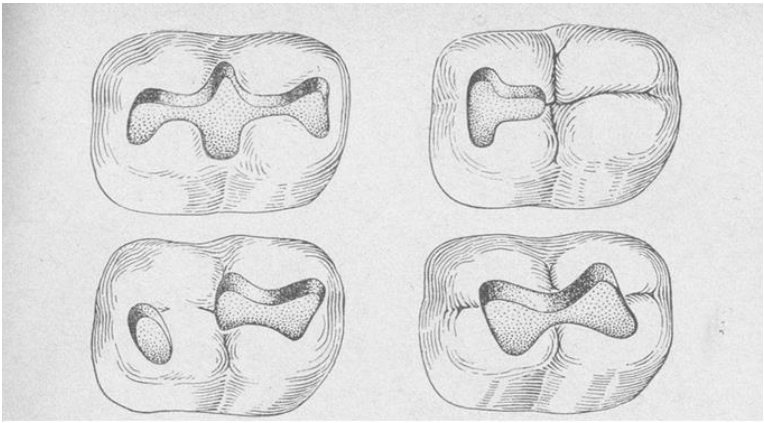
Consistently perform the main stages of preparation.

2. Have a clear idea of the possibilities of use and choice of tools (drills of various designs, excavators, etc.) to obtain the desired shape of the carious cavity.

3. Adhere to certain principles of preparation of a carious cavity: biological expediency, taking into account the limits of expansion of

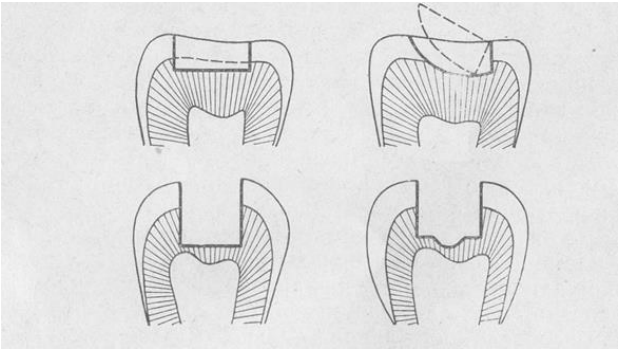
cavities and topography of pulp; technical rationality (correct work with tools).

Preparation of carious cavities of class I. Depending on the localization and distribution of the process, the following types of cavities are formed: rectangular, diamond-shaped, cross-shaped, oval, etc. The formed carious cavities of the I class have the most typical box-shaped form with steep walls and a flat bottom. In the case of preparation of deep carious cavities, the formation of a flat bottom may be impossible due to the danger of opening the pulp, especially in the projection of its horns. Therefore, in this case, create the bottom of the cavity, the shape of which repeats the contours of the pulp chamber. The carious cavity located on the masticatory surface of the tooth in the area of the fissures is called the central one.



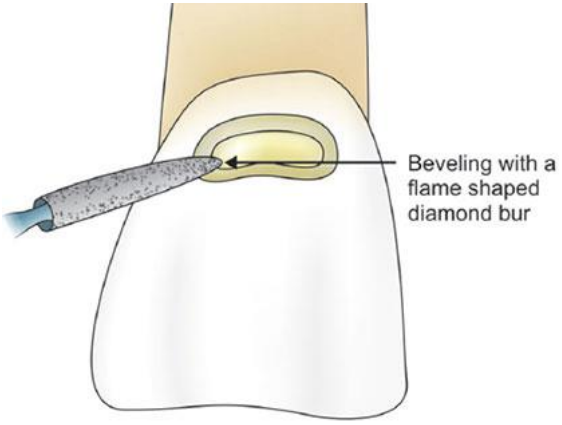
If there are two (or more) carious cavities located on the masticatory surfaces of premolars and molars, which are separated by sections of healthy tissue, they should be treated and filled separately. If carious cavities are separated by membranes of fabric of doubtful durability, it will be expedient to unite them in one cavity.

If the cavities are located on the buccal surface of molars above the equator of the crown with a thin layer of intact masticatory surface, the creation of a cavity only on the buccal surface of the tooth will be insufficient. In this case, as in the case of simultaneous damage to the buccal and masticatory surfaces of the tooth, form a cavity with an additional area on the masticatory surface. If the carious cavity on the buccal or lingual surfaces of molars is small and on the masticatory surface a significant layer of unchanged tooth tissue is preserved, forming a cavity only within the buccal surface.



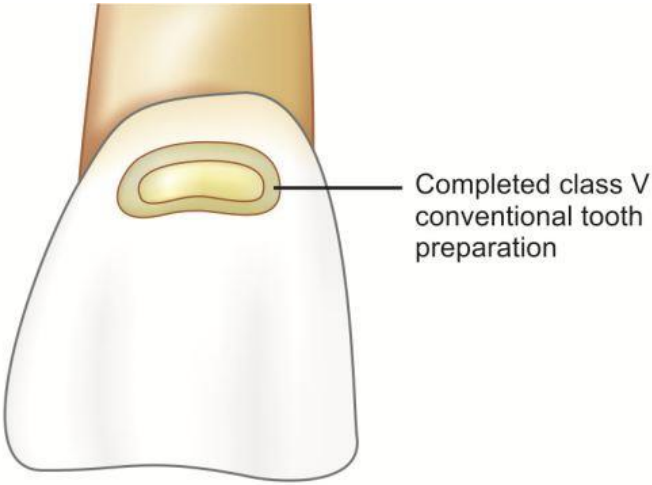
Class 5 preparation carried out almost as well as cavities of the I class. The opening and necrectomy of these cavities do not have pronounced features.

If there are two carious cavities on this surface, separated by a narrow strip of unaffected enamel, then both defects are combined into one cavity. The treated cavity must acquire a horseshoe shape or an elongated oval shape.



When treating a Class V cavity, it is important to keep in mind the possible damage to the pulp, so the depth of the cavity usually does not exceed 1.5 mm. Formed carious cavities of class V are often relatively small. Therefore, for better fixation of the seal, it is necessary that the straight plagues between the walls and bottom were clearly expressed. Sometimes a slight inclination of the walls towards the

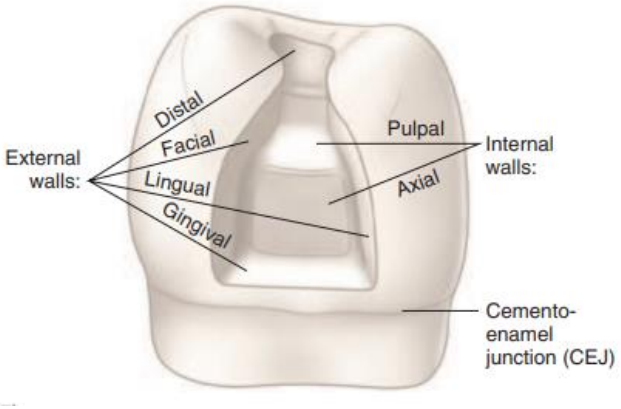
cavity and the formation of cuts on them by wheel-shaped and inverse conical burs is allowed.



Preparation of carious cavities **of class II (affected contact surfaces of premolars and molars),** in comparison with preparation of carious cavities of class I, is more complicated. This is due to the fact that the carious cavity located on these surfaces, in the presence of adjacent teeth is very difficult to detect and examine. To prepare such a cavity, it is necessary to access it by removing the layer of intact enamel and dentin from the side one of the tooth surfaces. This removal of the carious cavity is most convenient to perform from the masticatory, palatal or lingual surface of the tooth.

If the carious cavity is located on the contact surface above the equator, then after preparation it has a fairly typical box-like shape. In the case of placing a carious cavity on the contact surface below the line of the equator of the tooth, then, fully formed, it must contain two elements: the main cavity and the additional site.

Additional is formed on the chewing surface for better fixation of the seal and more even distribution of chewing pressure.



The disclosure of a class II carious cavity is associated with certain difficulties due to the removal of large masses of enamel and dentin while creating access to it. To do this, a wheel-shaped or cone-shaped boron is cut on the enamel of the masticatory surface in the projection of the carious cavity. You can use trepan, diamond bur, small carborundum heads. Then a small round (spherical) bur penetrate into the carious cavity, expand it, also using fissure burs. Much less often, especially if the carious cavity is located below the equator, it is opened from the lingual (palatal) or parietal surface. To ensure a better approach to the carious cavity, provided that the teeth are closely spaced, separation is used. It is carried out with the help of a special device - a separator or by sawing the contact surfaces of the tooth with a separation disk (the latter is rarely used). Especially carefully prepare the adjacent wall with the help of cone-shaped, conical and fissure burs; it must be placed at right angles to the bottom of the cavity. In the case of a shallow carious cavity on the contact surface, it is slightly expanded and continued on the chewing surface, creating there retention points in the form of a swallow's tail, etc. for better fixation of the seal. In the case of large enough carious cavities, the formation of an additional site or additional cavity is mandatory. The shape of the additional cavity can be varied (triangular, cruciform, in the form of a

swallow's tail, etc.), but it must provide a secure fixation of the seal and counteract the force that pushes it out.

In the case of carious lesions of both the medial and distal contact surfaces of large and small canines, an additional area on the masticatory surface is often made common. To prevent chipping of the buccal or lingual (palatal) walls of the cavity, it is necessary, shaping the cavity, to grind the tubercles of the crown.

Class III tooth preparations: are located on proximal surfaces of anterior teeth. Conventional Class III Tooth Preparation: The primary indication for this type of Class III preparation is for the restoration of root surfaces, preparation the portion on the root surface that has no enamel.

The outline form on the root surface. Box-like design may be considered, extending the external walls to sound tooth structure while extending pulpally to an initial depth of 0.75 mm. Any remaining infected dentin on the axial wall will be removed during the final tooth-preparation stage. The external walls are prepared perpendicular to the root surface. The cavosurface margins exhibit a 90-degree cavosurface angle and provide butt joints between the tooth and the composite material. Resistance form Extending the external walls pulpally to an initial depth of 0.75 mm thus providing adequate dimension for composite strength, placement of a retention groove (if necessary), and maintenance of strength of the gingival wall and margin. More likely

only a portion of a tooth preparation-the portion on the root surface that has no enamel margin-would be prepared in this manner.

Modified or a beveled conventional Class III Tooth Preparation. The beveled conventional tooth preparation for composite restorations is indicated primarily for replacing an existing defective restoration in the crown portion of the tooth. However, it also may be used when restoring a large carious lesion for which the need for increased retention and/or resistance form is anticipated.

Class III beveled conventional tooth preparations are prepared as conventional preparations with the addition of a cavosurface bevel or flare of the enamel rather than a butt joint margin.

The access of Class III: The lingual approach is preferable, unless such an approach would necessitate excessive cutting of tooth structure, such as in instances of irregular alignment of the teeth or facial positioning of the lesion.

Use a round carbide bur (No. 1/2, 1, or 2) or diamond stone, the size depending on the extent of the caries to prepare the outline form. The point of entry is within the incisogingival dimension of the carious lesion or defective restoration and as close to the adjacent tooth as possible, without contacting it.

Direct the cutting instrument perpendicular to the enamel surface, but at an entry angle that places the neck portion of the bur as far into the embrasure (next to the adjacent tooth) as possible. Incorrect entry overextends the lingual outline.

The advantages of restoring the proximal lesion from the lingual approach include:

1. The facial enamel is conserved for enhanced esthetics.
2. Some unsupported, but not friable, enamel may be left on the facial wall of a Class III or Class IV preparation.
3. Color matching of the composite is not as critical.
4. Discoloration or deterioration of the restoration is less visible.

Prepare the enamel walls perpendicular to the external tooth surface, with the enamel margin beveled.

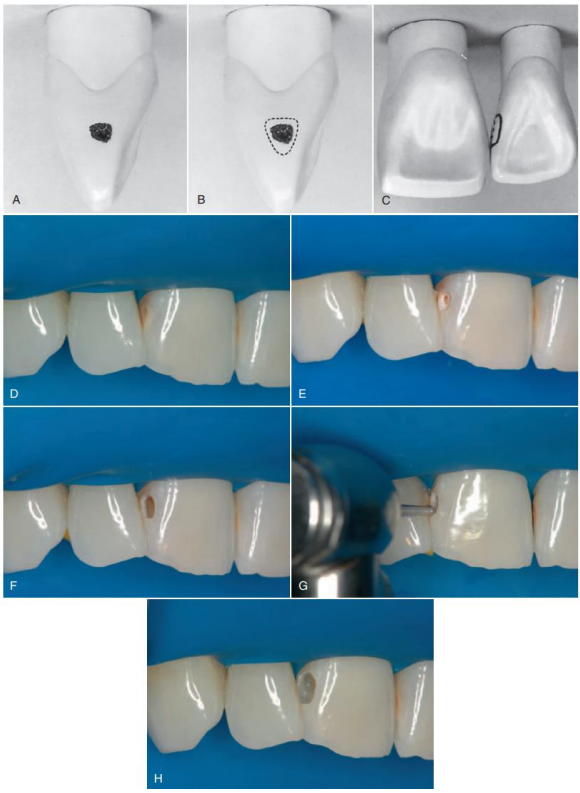
Extend the external walls to sound tooth structure during preparation of the outline form. The axial wall will be outwardly convex, Following normal external tooth contour and the DEJ, both

incisogingivally and faciolingually. Any remaining infected dentin or old, defective restorative material on the axial wall will be removed during the final tooth-preparation stage. The axial wall depth approximately 0.75 to 1.25 mm (0.2 mm inside the dentinoenamel junction (DEJ)).

Usually retention is obtained by bonding to the enamel and dentin and no groove retention is necessary. However, when replacing a large restoration or restoring a large Class III lesion, the operator may decide that retention form should be enhanced by placing groove (at gingival) and/or cove (at incisal) retention features in addition to the bonded tooth structure.

For most Class III using the beveled conventional preparation, the preparation would be complete at this time except for placing an enamel bevel, The cavosurface bevel provides more surface area for end-on etching of the enamel rods. The cavosurface bevel or flare is best prepared with either a flame-shaped or round diamond instrument, resulting in an angle approximately 45 degrees to the external tooth surface all accessible enamel margins usually are beveled, except for the gingival margin. This margin is usually not beveled if little or no enamel is present, or access is difficult for finishing procedures. In addition, bevels may not be recommended on lingual surface margins that are in areas of centric contact or subjected to heavy masticatory forces because composite has less wear resistance than enamel for with standing heavy attritional forces.

Modified Class III tooth Preparation. A modified tooth preparation is the most used type of Class III tooth preparation. It is indicated for small and moderate lesions or faults and is designed to be as conservative as possible. . Thus, the preparation design appears to be "scooped" or concave, the cavosurface margins in a beveled configuration the retention of the material in the tooth will result from the bond created between the composite material and the etched peripheral enamel.



A, Small proximal caries lesion on the mesial surface of a maxillary lateral incisor.
B, Dotted line indicates normal outline form dictated by shape of the caries lesion.
C, Extension (convenience form) required for preparing and restoring preparation from lingual approach when teeth are in normal alignment.
D–H, Clinical case showing conservative Class III preparation, facial approach.
D, Facial view of a caries lesion on the distal surface of the maxillary central incisor.
E and F, Obtaining access to carious dentin.
G, Infected dentin is removed with round bur.
H, Completed caries excavation.

Class IV

Class IV cavity preparation Class IV tooth cavity preparation is indicated for restoring proximal areas that also include the incisal surface of an anterior tooth. The Class IV composite restoration has provided the profession with a conservative treatment to restore fractured, defective, or cariously involved anterior teeth when, previously, a porcelain crown may have been the treatment of choice. The preoperative assessment of the occlusion is even more important for Class IV restorations because it may influence the tooth preparation extension (placing margins in non-contact areas).

Conventional Class IV Tooth preparation. The conventional tooth preparation design (preparation design with 90-degree cavosurface margins) has minimal clinical Class IV application except in those areas that have margins located on root surfaces.

Beveled Conventional Class IV Tooth Preparation. The beveled conventional Class IV tooth preparation is indicated for restoring large Class IV areas.

The outline form. Using an appropriate size round carbide bur or diamond instrument at high speed with air-water coolant. Remove all weakened enamel and establish the 2 initial axial wall depth at 0.5mm into dentin (because groove retention form will likely be utilized). Prepare the walls as much as possible parallel and perpendicular to the long axis of the tooth. Excavate any remaining infected dentin as the first step of final tooth preparation. If necessary, apply a calcium hydroxide liner. Bevel the cavosurface margin of all accessible enamel margins of the preparation. The bevel is prepared at a 45-degree angle to the external tooth surface with a flame-shaped or round diamond instrument. The width of the bevel should be 0.25 to 2 mm, depending on the amount of tooth structure missing and the retention perceived necessary.

Retention and resistance form. (Heavy occlusion and large Class IV require increased retention and resistance form). Thus, may dictate a more conventional tooth preparation form, with more resistance form features: to provide appropriate resistance form, the

preparation walls may need to be prepared in such a way as to resist occlusal forces. This often requires proximal facial and lingual preparation walls that form 90-degree cavosurface angles, which are subsequently beveled, and a gingival floor prepared perpendicular to the long axis of the tooth. This boxlike form may provide greater resistance to fracture of the restoration and tooth from masticatory forces.

Retention form features:

1. Etched beveled enamel margin and dentine surface. The bevel could be even wider than enamel margin bevel in class III.

2. Groove or other shaped undercuts placed in the dentin along line angles and into point angles wherever possible, without undermining the enamel. A gingival retention groove prepared using a No. 1/4 round bur. It is prepared 0.2 3 mm inside the DEJ at a depth of 0.25mm (half the diameter of the No. 1/4 bur) and at an angle bisecting the junction of the axial wall and gingival wall.

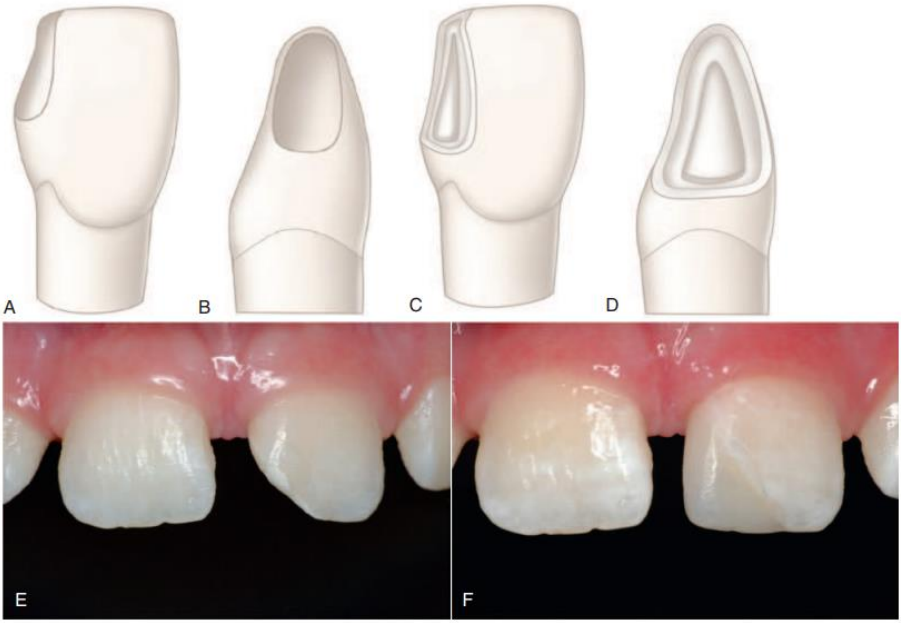
3. A dovetail extension onto the lingual surface of the tooth may enhance both the restorations strength and retention, but it is less conservative and therefore not used often. Although pin retention is sometimes necessary.

4. Pin placement prepared at 0.2-0.5 mm inside the DEJ.

Modified Class IV Tooth Preparation.

The modified Class IV preparation for composite is indicated for small or moderate Class IV lesions or traumatic defects. The objective of the tooth preparation is to remove as little tooth structure as possible, while removing the fault and providing for appropriate retention and resistance forms. Usually little or no initial tooth preparation is indicated for fractured incisal corners, other than roughening the fractured tooth structure. The cavosurface margins are prepared with a beveled configuration; the axial depth is dependent on the extent of the lesion, previous restoration, or fracture, but initially no deeper than 0.2 mm inside the DEJ. The retention is obtained primarily from the bonding strength of the composite to the enamel and dentin. The treatment of teeth with minor traumatic fractures requires less preparation than the beveled conventional. Example. If the fracture is

confined to enamel, adequate retention usually can be attained by simply beveling sharp cavosurface margins in the fractured area with a flame-shaped diamond instrument followed by bonding.



Preparation designs for Class IV (A and B), and larger preparation designs for Class IV (C and D). E and F, Direct composite restoration of a Class IV defect, before (E) and after (F).

Topic 6. Fundamentals of adhesion in aesthetic dentistry. Principles of adhesive bonding. Generations of bonds. Methods of adhesive treatment of the tooth surface.

Bonding and adhesion comprise a complex set of physical, chemical and mechanical mechanisms that allow the attachment and binding of one substance to another.

Enamel consists of 95% mineralized inorganic and 4% organic substance. Buonocore, in 1955, was the first to reveal the adhesion of acrylic resin to acid etched enamel. He used 85% phosphoric acid for etching, later Silverstone revealed that the optimum concentration of phosphoric acid should range between 30 to 40% to get a satisfactory adhesion to the enamel.

Standard treatment protocol for etching is use of 37% phosphoric acid for 60 seconds. But now studies have shown that enamel should not be etched for more than 15 to 20 seconds

Etching. It is the process of increasing the surface reactivity by demineralizing the superficial calcium layer and thus creating the enamel tags. These tags are responsible for micromechanical bonding between tooth and restorative resin.

Effects of Etching

- Cleanses debris from enamel.
- Produces a complex three-dimensional microtopography at the enamel surface.
- Increases the enamel surface area available for bonding.
- Produces micropores into which there is mechanical interlocking of the resin.
- Exposes more reactive surface layer, thus increasing its wettability.

Enamel Bonding

Bonding to enamel requires two clinical steps;
1) Acid etching.
2) The application of the adhesive resin to the etched surface.
Usually 37% phosphoric acid is used for 15 to 30 seconds.
The goals of enamel etching are:
1) to clean enamel surface from debris,
2) to increase the enamel surface area available for bonding, and

3) to partially dissolve the mineral crystallites to create retentive microporosities into which the resinous bonding agent can infiltrate and form retentive resin tags (micromechanical retention).
4) In addition, acid etching increases the surface energy and lowers the contact angle of resins to enamel.

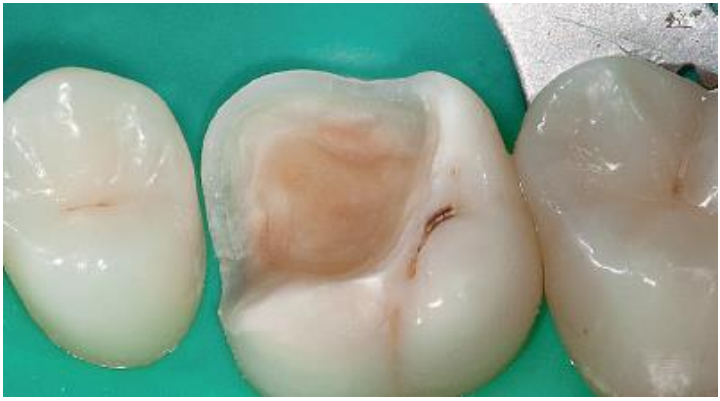
Procedure

Apply acid etchant in the form of liquid or gel for 15 to 30 seconds.
• Wash the etchant continuously with water for 10 to 15 seconds.
• Note the appearance of a properly etched surface. It should give a frosty white appearance on drying.
• If any sort of contamination occurs, repeat the procedure.
• Now apply bonding agent and low viscosity monomers over the etched enamel surface.
Generally, enamel bonding agents contain Bis-GMA or UDMA with TEGDMA added to lower the viscosity of the bonding agent.
The bonding agents due to their low viscosity, rapidly wet and penetrate the clean, dried, conditioned enamel into the microspaces forming resin tags. The resin tags which form between enamel prisms are known as Macrotags.
• Finer network of numerous small tags is formed across the end of each rod where individual hydroxyapatite crystals were dissolved and are known as microtags. These microtags are more important due to their larger number and greater surface area of contact. Micro and macrotags within the enamel surface constitute the fundamental mechanism of enamel-resin adhesion.

Tooth 26: Acid etching of enamel

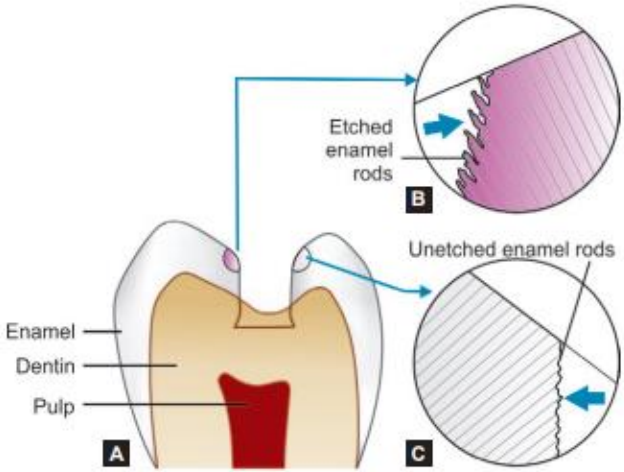
Acid etching of dentin

Post-etching clinical view



Post-bonding view

Difference in appearance of etched and unetched enamel rods



DENTIN BONDING

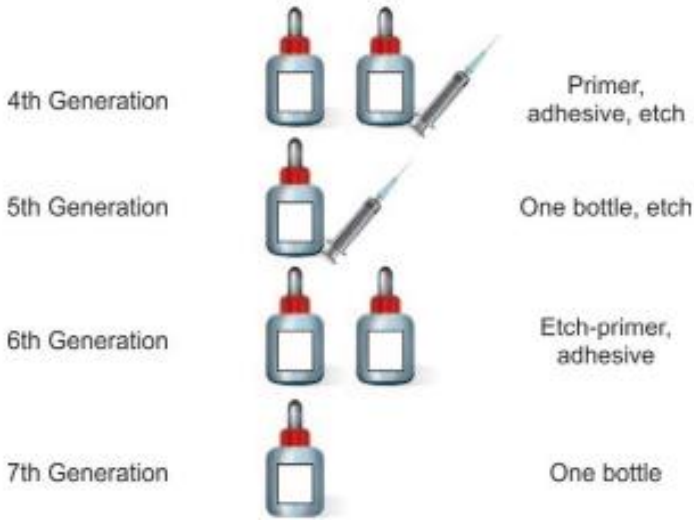
Bonding to dentin has been proven more difficult and less reliable and predictable than enamel. This is because of difference in morphologic, histologic and compositional differences between the two.

Problems Encountered during Dentin Bonding

- In enamel, it is 95 percent inorganic hydroxyapatite by volume, in dentin it is 50 percent. Dentin contains more water than does enamel.
- Hydroxyapatite crystals have a regular pattern in enamel whereas in dentin, hydroxyapatite crystals are randomly arranged in an organic matrix.
- Presence of smear layer makes wetting of the dentin by the adhesive more difficult.
- Dentin contains dentinal tubules which contain vital processes of the pulp, odontoblasts. This makes the dentin a sensitive structure.
- Dentin is a dynamic tissue which shows changes due to aging, caries or operative procedures.
- Fluid present in dentinal tubules constantly flows outwards which reduces the adhesion of the composite resin.

Ideal Requirement of Dentin Bonding Agent Ideal requirements of dentin bonding agent are:

• Provide optimal bond strength similar to bond strength of composite to resin.
• Biocompatibility.
• Long-term stability.
• Attain high bond strength early.
• Be easy to apply and not be technique sensitive.



Classification of Modern Adhesives Based on Generations

• First generation bonding agent.
• Second generation bonding agent.
• Third generation bonding agent.
• Fourth generation bonding agent.
• Fifth generation bonding agent.
• Sixth generation bonding agent.
• Seventh generation bonding agent.

Based on Smear Layer Treatment

- Smear layer modifying agents.
- Smear layer removing agents.
- Smear layer dissolving agents.

Generation	*No. of steps*	*Steps description*
First	2	Etch enamel + Apply adhesive
Second	2	Etch enamel + Apply adhesive
Third	3	Etch enamel + Apply primer + Apply bonding agent
Fourth	3	Total etch + Apply primer + Apply bonding agent
Fifth	2	Total etch + Apply bonding agent
Sixth	1	Apply self-etch adhesive
Seventh	1	Apply self-etch adhesive

Topic 7. Principles of working with composite materials. Features of material introduction. Methods of stratification. Approaches to the composite materials' adaptation.

Restorations in the anterior area of the oral cavity involve the biomimetic reproduction of the natural teeth characteristics in order to achieve aesthetic restorations as well as integrated into the dental arcade. For this, two essential steps are needed: dental color determination and selection of composite resin materials to be layered:

1. Color evaluation. Color should be understood as a result of the interaction of three dimensions known as hue, saturation and brightness.
2. Dental composites materials and stratification techniques will be chosen in order to create a restoration that matches and blends in the adjacent natural dental tissues.

Layering methods used for direct anterior teeth restorations

- One-layer layering techniques is a common and simple layering technique, that involves a single group of materials, either dentin or enamel, to restore the defective natural tooth. It is usually used for masking the white spots on the teeth.

One layer technique for treating the white spots on the anterior teeth: a) initial aspect, b) after treatment

- Two-layer stratification techniques requires a higher level of clinical skill , because it uses both dentin and enamel materials during the restoration. It is indicated in case of cervical lesions or for direct composite veneers.

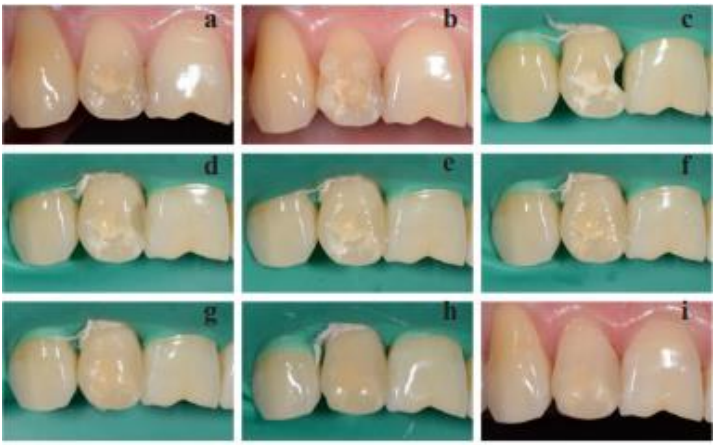
(a, b) – Two layer layering technique used in case of cervical abrasion on: a) initial aspect of cervical lesion, b) final aspect immediately post-op

- Three layer stratification techniques: this is the advanced level of the layering technique, when opaque dentin, body dentin and enamel materials are used in combination to block the transmission of light. As opaque materials are used, a good selection of the hue and thickness of the dentin and enamel layers are essential to achieve an aesthetically successful result. It is used to mask the discoloration of teeth with dyscromies.

Three layer layering technique for masking teeth discoloration

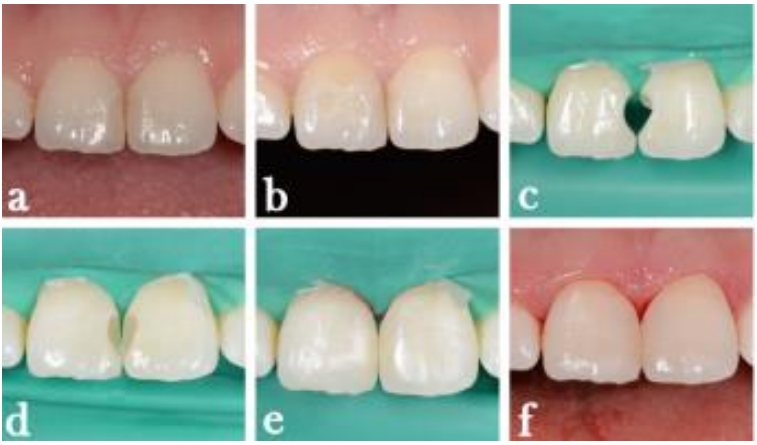
- Complex layering techniques involves materials with special color effect (pigments) in restorations. These materials are usually placed between the dentin and enamel layers of natural teeth or of the restorative materials.

The use of special color effect pigment to mask the white spot; warm-gold material (chroma) has been selected to increase the chroma level in the medial area of dentine: a) initial aspect, b) color determination with button try composites, c) aspect of the prepared tooth, d) enamel palatal wall, e) dentin layer, f) pigment placement, g) enamel buccal layer, h), i) final aspect of the restoration



- Anatomical layering technique involves using successive layers of dentin, enamel and incisal composite, so that more realistic color depth could be obtained. In the same time, surface and optical characteristics that mimic nature are aimed.

Anatomical layering technique: a) initial aspect of cl III restoration located on 1.2, 2.1; b) color determination with button try composites; c) aspect of prepared tooth; d) enamel palatal layer; e) dentin layer; f) final aspect with the buccal enamel layer in place



- Blended shading technique. This technique uses two or more shaded

restoration materials to match the actual hue of a tooth in different regions. Restorative materials with different colors are used and mixed with overlapping surfaces to create the desired effect.

- Natural layering technique. It is based on a simplified and more reliable layering technique with only two layers (dentin and enamel) to perfectly mimic the structure and appearance of the tooth. This new approach allows the combination of different enamel and dentine nuances with immediate comparison with the natural tooth. Clinical applications and stratification of the composites uses only one universal dentine shade (with the opacity close to that of a natural tooth) with several levels of chromacity and three types of enamel for young, adults and old patients, with different shades and levels of translucency. This concept is used in combination with dental materials classified only in dentin and enamel shade according to the age of natural tooth structure: Miris and Miris2 (Coltene whaledent), Ceram-X duo (Dentsply), Enamel HFO Plus (Micerium), Inspiro (Edelweiss DR), and Essentia (GC).

Natural layering technique a) initial aspect of cl. III restoration located on 2.2; b) color checking with button try composites; c), d) aspect of prepared tooth; e) enamel palatal layer; e)dentin layer; f) final aspect with the buccal enamel layer in place; g) final aspect 24h post-op.

Topic 8. Restoration of cavities I-II classes according to Black. Adaptation matrices and restoration of the contact point in the direct restoration technique.

Techniques for Direct Composite Restoration

Bulk Technique. When applying the bulk-fill technique, a composite specifically developed for this purpose is placed into the cavity in a single layer (i.e. increment), in up to a thickness of 4 mm. Following the formation of the masticatory surface, the whole filling is cured with light. Disadvantages like greater polymerization shrinkage makes it a non-viable option, nevertheless the primary advantage is that the bulk material avoids the formation of incremental voids.

Conventional Incremental Techniques

a) Horizontal Layering Technique

In this technique, horizontal placement of <2.0 mm thickness of composite restorative material against the prepared cavity surface is done and cured. But the primary disadvantage is that there is an increase of the C-factor, which in turn increase the shrinkage stress.

b) Oblique Layering Technique

Here, wedge-shaped composite increments are placed against the prepared cavity surface and cured twice, throughout the cavity walls and the occlusal surfaces. The primary advantage in this technique is that there is less C-factor, which prevents the distorted cavity walls which is usually found in other restorative techniques.

c) Vertical Layering Technique

In this technique, small increment of composite material is placed vertically from one side of the wall to the other wall. Curing of the material is done from the opposite side of the wall from where the composite is placed, reducing the space at the gingival wall caused by polymerization shrinkage.

d) Centripetal Buildup Technique

Initially, a very thin proximal layer is formed and cured, which strengthens the composite and reduces the cervical gap. Further any void which is present would not be a problem as the addition of the next layer of composite fills it, as the composite material is condensed.

e) Split-Increment Horizontal Layering Technique

The horizontally added composite which connects the walls of the prepared cavity with the floor of the cavity produces the highest amount of strength with an unfavorable C-factor ratio of 5, after photo-curing it. Horizontal increment is divided into four triangle-shaped portions, with a portion placed against a cavity wall and a part of the floor, one diagonal cut is filled completely with dentin shade composite and cured. Another cut diagonal is filled and cured, one half at a time.

f) Successive Cusp Buildup Technique

Each cusp is built individually, to the occlusal level. Then small increments are added with minimum manipulation is done prevent any material voids. Even though these are time consuming, they provide good strength and excellent aesthetic results.

g) Three-Site Technique

In this technique, light curing of composite with the help of clear matrix along with reflective wedges helps in achieving excellent results. Here, the composite is cured by directing the curing light through the matrix and wedges, to prevent any void at the gingival margin by preventing the polymerization vectors. Addition of wedge shaped composite material in increment is done to further inhibit distortion of cavity walls and reduce the C-factor. Here, polymerization is achieved by cavity walls as well as through the occlusal sides.

Esthetic Techniques

a) Stratified Layering Technique

High chroma of composite restorative material is placed in the dentin at the center of the preparation and a low chroma composite placed at the cusp walls. This helps in achieving good aesthetic results.

b) Separate Dentine and Enamel Buildup

Increments of composite is taken and applied in the form of slopes against the prepared cavity walls up to the level of the amelo-dentinal junction, followed by the addition of the final “enamel” increments. Alternatively, using a dark composite shade gives a better natural appearance for the bulk of the restoration with a translucent or a lighter shade being used for the “enamel” increment.

c) Dual-Shade Layering Technique

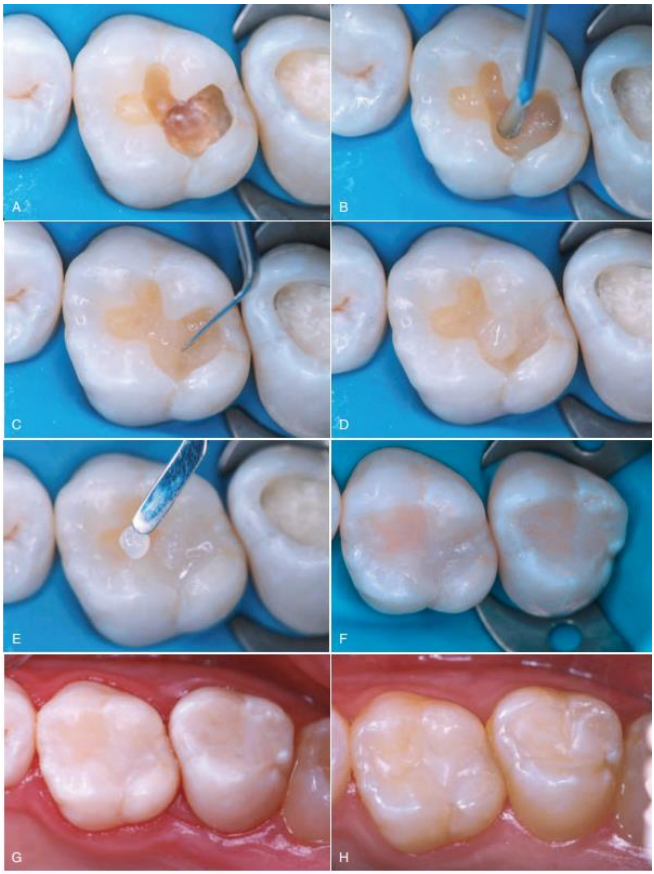
After the initial procedures which include etching and adhesive application, an addition of opaque composite (dentine material) is

added, carved, and cured. Selection of the correct shade with the correct Chroma for the dentin provides the best results. Palatal, proximal, and labial enamel increments are then added over the opacious central core at about half the thickness of residual enamel.

d) Polychromatic Layering Technique

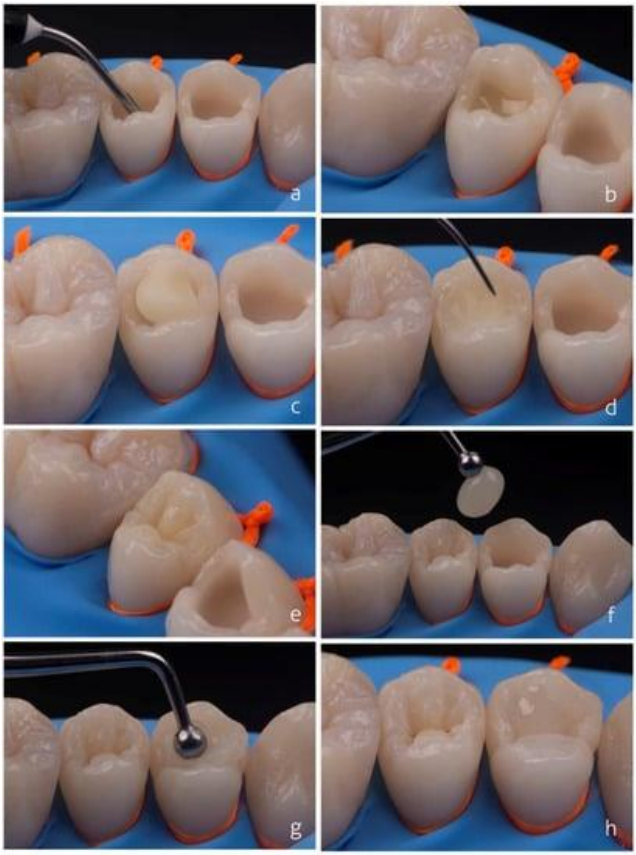
In this technique, different shades of composite material, opalescent are added as needed by the dentist. The main goal in this technique is to achieve the best aesthetic results which should mimic/resemble the natural tooth. Herein, the most widely accepted stratification technique was proposed by Lorenzo Vanini.

Class I direct composite restoration and conservative composite restoration



A, Mandibular second molar with suspicious occlusal pits; mandibular first molar with questionable sealant. B, After rubber dam isolation. C, Initial exploratory preparation reveals caries extending toward the dentinoenamel junction (DEJ). D, Conservative preparation on the second molar; the first molar was minimally prepared. E, Complete Class I direct composite restoration on the second molar; the first molar received a conservative composite restoration with flowable composite. F, Final restorations after the rubber dam was removed and the occlusion was checked

Examples of 'bulk and body' restorative techniques



*Examples of 'bulk and body' restorative techniques. Bulk and body: restoring the dentin portion of the cavity with flowable bulk-fill composite (**a**,**b**), insertion of enamel composite (**c**), sculpture (**d**), and final aspect (**e**). Bulk and go: insertion of regular bulk-fill composite as single increment (**f**), accommodation of the increment (**g**), and final aspect of the sculpture (**h**).*

When a restoration involves an interproximal surface, it is not possible to achieve a properly adapted restoration without a matrix band.
A matrix band creates a temporary interproximal surface, and, when appropriate, a matrix retainer secures the matrix band in place.

Varieties:

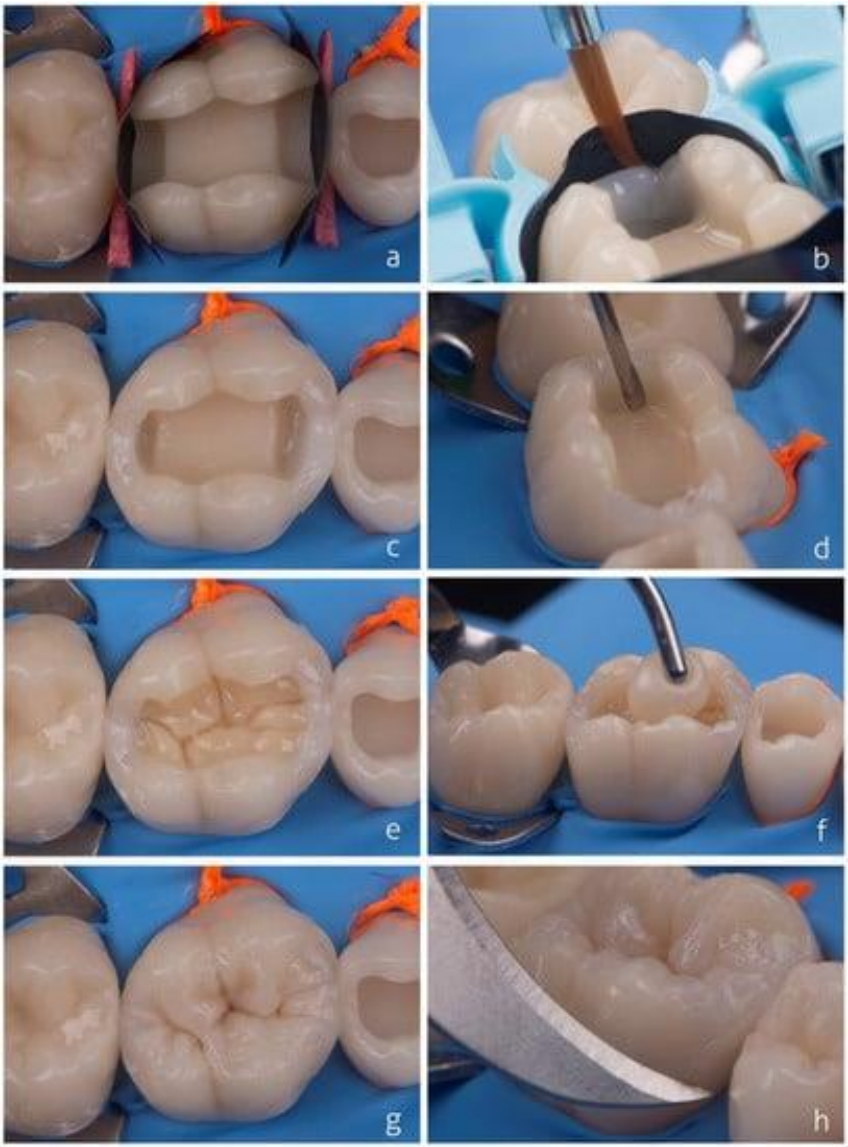
1. Celluloid strip
   - Used for anterior restorations with composite materials.
   - Also referred to as clear transparent matrix strip.
   - Single use.
   - Disposed of in the sharps' container.
   - Preformed posterior variety can be available.
2. T-band matrix (straight and curved)
   - Most commonly used in paedodontics.
   - Single use.
   - Disposed of in the sharps' container.
3. Stainless steel matrix band (universal)
   - Used in conjunction with amalgam restorations and a matrix retainer.
   - Single use
   - Disposed of in the sharps' container
   - Different sizes and shapes available.
   - Available in pre-contoured shapes.

Classification of matrices according to type of tooth preparation

Types of preparation	*Matrices and retainers*
• Class I with buccal or lingual extension	• Double banded Tofflemire matrix
• Class II tooth preparation	• Ivory matrix number 1 • Nystrom's retainer
• Class II mesio-occlusodistal (MOD) tooth preparation	• Ivory matrix number 8 • Tofflemire matrix • Steele's Siqveland self-adjusting matrix • Anatomical matrix band • 'T' shaped matrix band • Retainerless automatrix
• Class III tooth preparation	• 'S' shaped matrix band • Cellophane matrix strips • Mylar strips
• Class IV tooth preparation	• Plastic strips • Aluminium foil • Transparent crown form • Anatomic matrix
• Class V tooth preparation	• Custom made plastic matrix
• Direct tooth colored and all other complex	• Cellophane matrices • Anatomic matrices preparations • Aluminium or copper collars • Transparent plastic crown forms

Class II restoration with composite. Positioning of partial matrices and wedges before application of adhesive system (**a**). Composite is placed in the proximal area and pre-polished with a brush before photoactivation (**b**). Aspect of the cavity with both proximal walls built with enamel composite (**c**). Proximal box filled with flowable bulk-fill composite (**d**). Restoration of artificial dentin and occlusal map design (**e**). Insertion of enamel composite on the occlusal surface (**f**). Aspect of

the final occlusal anatomy (**g**) and finishing of proximal surfaces with scalpel blade (**h**).

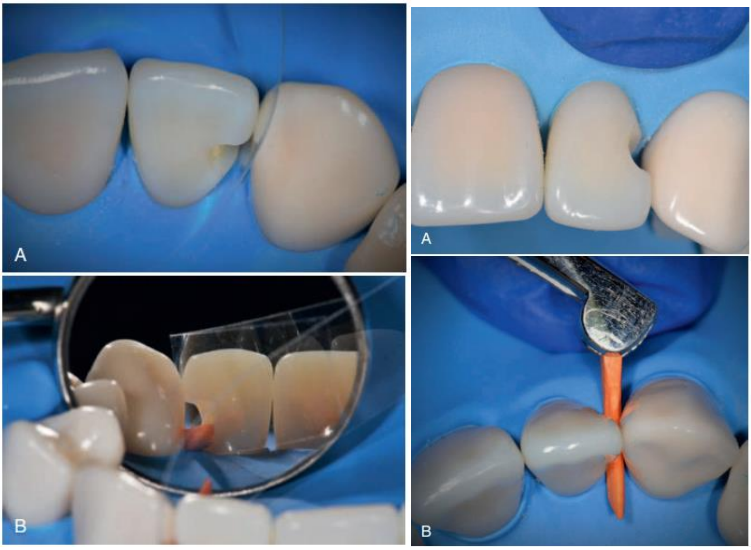


Class V direct composite restoration. The composite can be inserted with a hand instrument or syringe. Composites and RMGIs are recommended for Class V restorations. A light-cured material is recommended for most Class V preparations because of the extended working time and control of contour before polymerization. Careful placement allows for minimal need of rotary finishing. These features are particularly valuable when restoring large preparations or preparations with margins located on cementum because rotary instrumentation can easily damage the contiguous tooth structure and/or compromise the marginal integrity of the restoration.

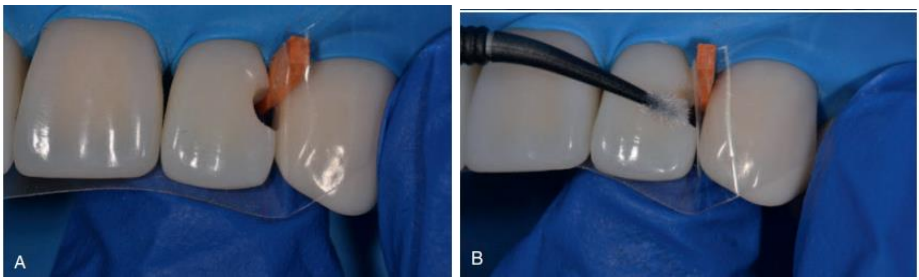
The number and position of the increments depend on the size and depth of the preparation. For large and deep preparations, an incremental technique is recommended. Deep preparations with retentive undercuts are usually filled with at least two axially placed increments with minimal contact on the occlusal/incisal and gingival walls.

Topic 9. Restoration of cavities III-IV Black classes. Silicone key (template) technique.

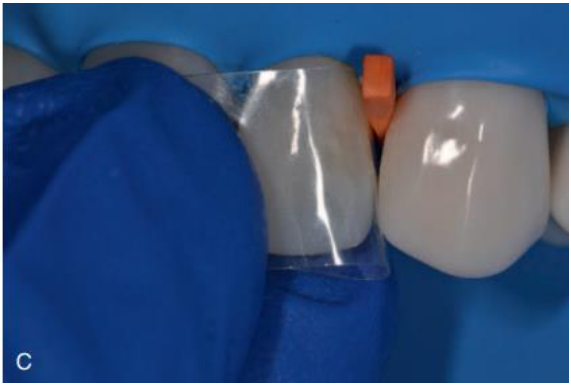
Class III Black composite restoration



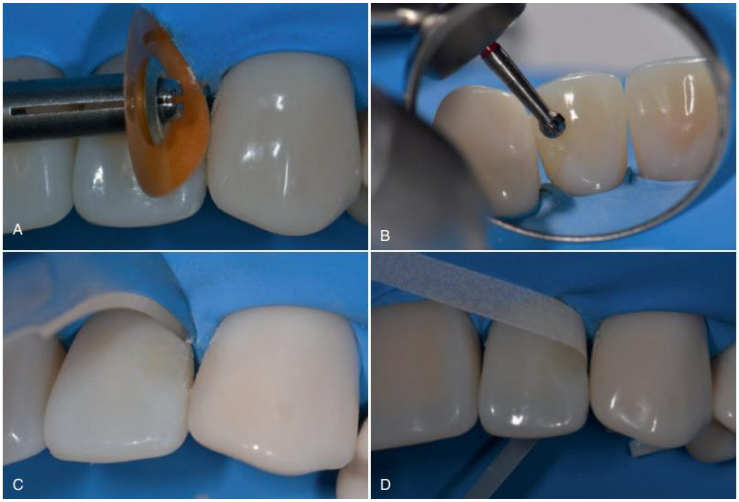
a. Inserting and wedging Mylar strip matrix. A, Strip with concave area next to the preparation is positioned between teeth. B, Strip in position and wedge inserted. The length of the Mylar strip can be reduced as needed.
b. Using a triangular wood wedge to expose gingival margin of large proximal preparation. A, The dam is stretched facially and gingivally with the fingertip. B, Insertion of wedge (the dam is released during wedge insertion).



c. Insertion of light-cured composite. A, Bonding adhesive is applied and light cured. B, The lingual aspect of the strip is secured with the index finger, while the facial portion is reflected away for access. C, After insertion of the composite, the matrix strip is closed and the material is cured through the strip.

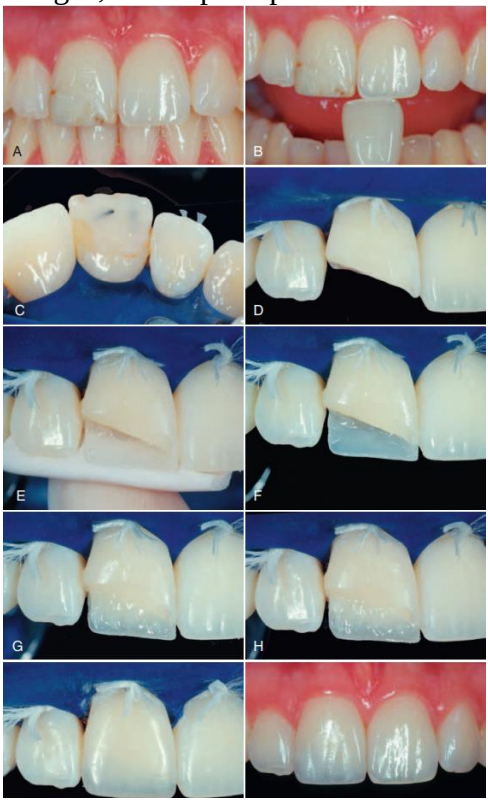


d. Finishing composites. A, Abrasive disk mounted on mandrel can be used for finishing when access permits. B, The round carbide finishing bur is well suited for finishing lingual surfaces. C, The No. 12 surgical blade in Bard-Parker handle can be used for removing interproximal excess. D, The abrasive strip should be curved over the area to be finished.



Class IV tooth preparation and restoration. A, Extraoral view, minor traumatic fracture. B, Intraoral view. C, Fractured enamel is roughened with a lame-shaped diamond instrument. D, The conservative preparation is etched, while adjacent teeth are protected with Mylar strip. E and F, Contouring and polishing the composite. G, Intraoral view of the completed restoration. H, Extraoral view.

Custom lingual matrix. A, Facial preoperative view. B, Preoperative shade determination. C, Lingual preoperative view after placement of the rubber dam. D, The old composite material is removed, and a conservative enamel bevel is placed. E, The lingual matrix obtained before tooth preparation is positioned and guides the application of the irst lingual composite layer. F, The lingual composite layer determines the future contours of the restoration; note the intrinsic material translucency. Custom lingual matrix. G, The dentin buildup can be made directly against the lingual enamel; the clinician can visualize the whole tooth shape and place dentin with appropriate thickness and relation to the incisal edge. H, Color modiier or tint blue material is applied between the dentin lobes and slightly below the incisal edge to simulate the blue natural opalescence. I, View of the completed restoration (with second enamel layer placed on the buccal surface), after inishing. J, Facial postoperative view.



Matrix transfer techniques (MTTs) are commonly used to directly convey planned information from a diagnostic wax-up (either analogue, digital or intra-oral mock-up) to a definitive restoration.

Partial contour MTTs commonly transfer just the palatal or lingual shape of the planned information (the 'shell'). The shell is particularly useful for upper anterior teeth as this defines the planned functional surfaces in addition to facilitating aesthetic composite layering techniques. This technique also allows for separate formation of smooth anatomical contact points. The ability to control each aspect of the build-up has the advantages listed above; however, the compromise is that this technique will tend to be more time-consuming.

a, b) Previous freehand addition of composite. Patient complained of chipping, gaps, shape issues, centre-line cant, white marks, inability to clean and bleeding gums because of ledges. c) Removal of existing composite. d, e) Wax-up to address these requests following removal of previous composite additions. f) Mock-up to assess aesthetics, functional occlusion and speech using temporary crown material in a

putty of the wax-up. Patient happier with this but midline cant still evident. Patient informed of possible incomplete resolution without preparation, which was accepted. g) Proposed additions light-curable from buccal, aesthetic shade layering planned, therefore rigid opaque matrix used for partial transfer made from bite registration silicone. Partial 'shell' transfers, allowing aesthetic shade layering. h) Centre-line cant correction and control over gingival contour through use of contoured interproximal metal matrices. i) Layered approach. j, k) Post-operative result. l, m) Two-years follow-up, showing improved gingival health and acceptable maintenance of aesthetics before re-polishing

Full contour MTTs.

Full contour MTTs allow placement of all of the planned shape in composite at once. These matrices therefore must allow light transmission to facilitate light curing with the matrix in place. Single shade restorations are more commonly placed with full contour MTTs, as layer thickness is difficult to control.

Alternate tooth technique.

This involves waxing up all of the planned teeth, duplicating this model in stone and then removing every other wax addition which has been added to the teeth.

Combined techniques.

Different MTTs can be used on the same patient, based on the specific situation and staging required. When full contour and partial contour MTTs are to be used on the same patient in the same arch, it is advised to complete the full contour restorations first.

Topic 10. Principles of modeling the shape of teeth using various techniques in the implementation of aesthetic restorations.

Compared to indirect restorations, where contact, contour and the occlusion is well controlled and achieved in the laboratory, the direct restorations pose challenges in achieving the same intra-orally.

One technique that is proposed by Dr. Waseem Riaz is a 'Stamp technique' practiced for direct composite resin restorations to obtain the precise occlusal topography easily. It has also been reported for vertical bite reconstruction of worn out dentitions.

Stamp is like an index, which is the mini impression made by putty before tooth preparation for a full crown preparation. This stamp replicates the original anatomy of the tooth structure by virtue of copying the original unprepared tooth structure.

This technique is used where the occlusal surface is almost intact before the restorative procedure. For mild or moderate cavitated carious lesions, the cavitation are blocked with wax and occlusal pattern is sculpted on the wax.

Technique

The cavitated tooth to be restored was isolated under rubber dam. Cavitated caries mesial to oblique ridge was blocked out by base plate wax. A single coat of petroleum jelly/ vaseline which acts as separating agent was applied onto the occlusal surface with an applicator tip.

The tip of a microbrush was trimmed with the scissors for ease of handling. Flowable composite material was applied to the occlusal surface, and the microbrush was placed over it with a gentle digital pressure. It was light cured and thus occlusal stamp was fabricated.

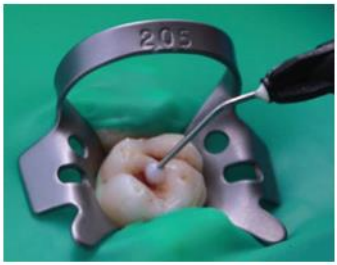
Microbrush stamp technique:

- Decreased chair side time in finishing and polishing procedure.
- Replicates original occlusal anatomy since it is the copy.
- No need of special instruments (XTS anti stick instruments).

Step . 1 Pre – operative photograph, Class I superficial cavitated caries in left maxillary molar with palatal extension

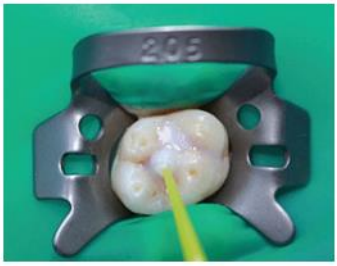
Step 4.The tip of the microbrush is cut for better handling characteristics

Step 2. Mesial cavitated occlusal caries being blocked with base plate wax



Step 5 . Flowable composite applied over the wax on the mesial cavity as well as on the distal aspect

Step 3. Application of a single coat of petroleum jelly with applicator tip



Step 6 . Microbrush is pressed on the flowable composite with gentle digital pressure

Step 7.Microbrush stamp is being cured with LED Curing unit

Step 10 . after pumice prophylaxis

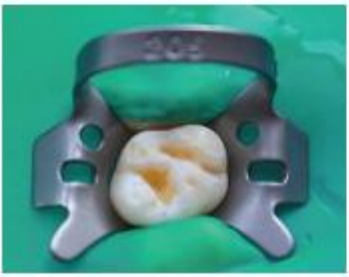
Step 8. Occlusal stamp made using microbrush stamp technique

Step 11 . Caries excavation with tungsten carbide bur using Airotor handpiece

Step 9. pumice prophylaxis done with pumice slurry using rubber cup in a contraangle handpeice in slow speed

Step 12 . caries excavation/ cavity preparation

Step 13. Selective enamel etching with 37% ortho phosphoric acid



Step 14 . Etched enamel and moist dentin

Step 15 . Bonding agent applied and cured

Step 16 . final layer of resin composite applied

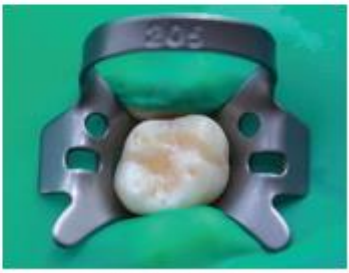
Step 17 . Cling film applied covering the occlusal surface

Step 18 . Microbrush stamp pressed over the cling film

Step 19 .Curing done with LED curing lightn(480nm)

Step 20. Polishing with POGO -1

Step 21. Polishing with POGO -2



Final restoration

After final increment was added, a cling film was applied onto the surface. The fabricated microbrush stamp was pressed over the cling film. Upon removal of the cling film, the gross excess was removed with sharp hand instrument. The resin composite was then cured. Polishing was carried out using single step POGO composite polishing kit

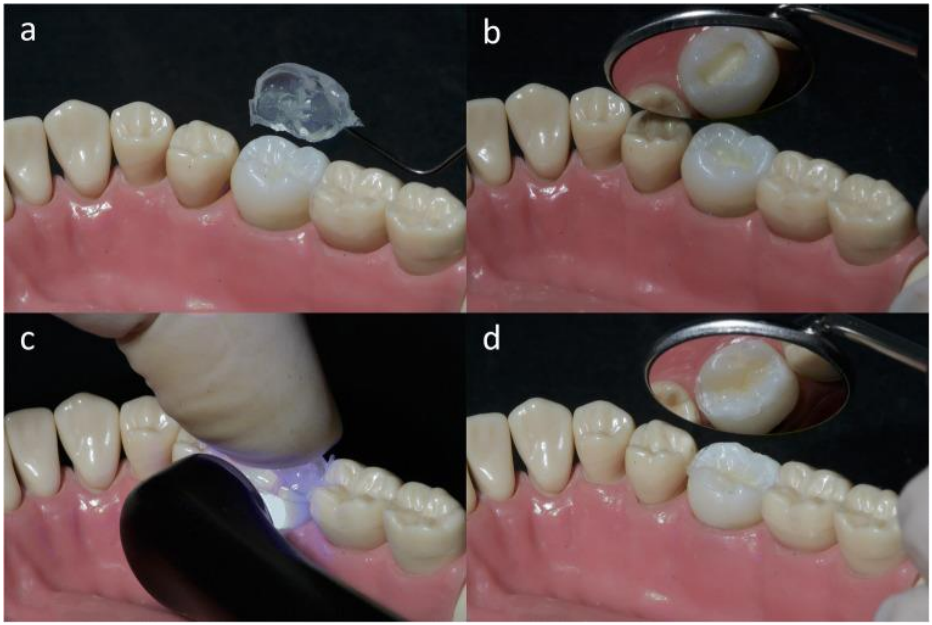
PTFE stamp technique

The surface layers of the restoration were formed using a stamp made prior to cavity preparation with a flowable light-cure resin paste and an isolating 75-µm PTFE tape. After removing the stamp and the PTFE tape, any excess of the RBC was carefully removed and only then was the restoration polymerized for 20 s by the light-curing lamp. The surface of the restoration was polished using the pre-polisher and the high gloss polisher.

Rehabilitation of the occlusal surface with a resin-based composite (RCB) restoration using the PTFE stamp technique with a flowable light-cure resin paste and PTFE tape (Unitape, Unipak A/S, Galten; Denmark): a light-cured stamp with a microbrush handle, b prepared and etched cavity, c forming the last layer, PTFE tape and stamp in position, d removed stamp with PTFE tape in situ, e removing the PTFE tape before excess removal and light curing, and f restored cavity.

Silicone stamp technique

The surface layers of the restoration were formed using a stamp made prior to cavity preparation with a transparent addition-vulcanizing 2-component vinyl polysiloxane. The surface layer was polymerized for 20 s from the buccal and for 20 s from the lingual side of the stamp with the light-curing lamp while a defined digital pressure of 5 N was applied to the top of the silicone stamp. The pressure was controlled by placing the tooth on a balance. The restoration was then light-cured from above for 20 s before and after the silicone stamp was removed.



Rehabilitation of the occlusal surface with a resin-based composite (RCB) restoration using the silicone stamp technique with a transparent addition-vulcanizing 2-component vinyl polysiloxane: a silicone stamp, b prepared and etched cavity, c light-curing while a defined digital pressure of 5 N was applied, and d light-cured but unfinished restoration. Afterwards, any excess of the RBC was removed with a diamond bur.

Recent advances in minimally invasive techniques

1. Microabrasion. This is a minimally invasive technique used to remove superficial enamel discolorations and defects. It involves mechanical abrasion of the outer enamel layer using a combination of mild abrasive agents and a high-speed handpiece. This procedure is particularly effective for addressing white or brown demineralized spots, fluorosis stains, and mild enamel hypoplasia. Microabrasion can significantly improve the esthetics of affected teeth without the need for invasive interventions or extensive tooth preparation. It is often

combined with other minimally invasive techniques such as enamel bonding or bleaching to achieve optimal results.

2. Resin infiltration. Resin infiltration is used to treat incipient or non-cavitated carious lesions, particularly those affecting the enamel. This involves the infiltration of a low-viscosity resin into the porous enamel structure, which effectively arrests the progression of the lesion and improves its appearance. The resin infiltrant fills the voids within the enamel, reinforcing its structural integrity, and masking the discoloration caused by carious lesions. This minimally invasive approach avoids the removal of healthy tooth structures and is an effective preventive measure for halting the progression of early caries. Resin infiltration is often used in combination with other minimally invasive restorative techniques to provide comprehensive care for dental caries.

3. Bleaching. Tooth bleaching is a common minimally invasive technique used to address tooth discoloration and enhance smile esthetics. It involves the application of bleaching agents such as hydrogen peroxide or carbamide peroxide to remove intrinsic and extrinsic stains from the tooth structure. Bleaching can be performed in-office under professional supervision or at home using customized trays and bleaching gels. This technique is effective for improving the shade and brightness of teeth without the need for invasive procedures. It is particularly beneficial in patients with tooth discoloration caused by aging, tobacco use, or certain dietary habits. Bleaching offers a conservative and cost-effective approach to enhance smile esthetics and can be combined with other minimally invasive procedures, such as microabrasion or composite resin restorations, for comprehensive results.

4. Digital dentistry and Computer-aided design/computer-aided manufacturing (CAD/CAM) technology. CAD/CAM enables the precise fabrication of restorations, reducing the need for traditional impressions and facilitating minimally invasive treatment planning.

5. Biomimetic approaches. Biomimetic dentistry aims to mimic the natural structure and function of teeth using materials and techniques that closely resemble natural tooth properties, resulting in enhanced longevity and esthetics.

6. Laser-assisted techniques. Dental lasers provide precise and minimally invasive treatment options for various procedures, including cavity preparation, soft tissue management, and tooth whitening.

7. Nanotechnology in restorative materials. Nanomaterials offer improved physical and mechanical properties, enabling the creation of stronger and more esthetic restorations with minimal tooth preparation.

Topic 11. Carving, finishing, and polishing of composite restorations.

Mechanical finishing is defined as the procedures associated with contouring the restoration, eliminating excess resin at the margins, and performing the final polishing. It is a process that may be divided into three components:

- Removal of oxygen-inhibited layer.
- Gross finishing.
- Final polishing.

Removing the Oxygen-Inhibited Layer. The oxygen-inhibited layer (OIL) is a complicating factor after any procedure involving composite resin—both with direct and indirect restorations. (Indirect restorations are affected because they are conventionally bonded with composite resin cements.)

The presence of the oxygen-inhibited layer results in the following:

- Reduced speed and quality of finishing procedures, since the unpolymerized resin clogs the cutting surfaces of the rotary finishing instruments.
- Discoloration and wear in the mid-term. This particularly affects areas such as the interproximal, where it is challenging to remove the OIL with finishing instruments.

The Solutions: the three leading solutions suggested in the scientific literature are:

- The matrix band acting as a physical barrier to the oxygen during photo-polymerization (light-curing).
- Photo-polymerization in an argon-rich atmosphere. Although enhanced degrees of conversion (DC) have been demonstrated in the lab, this approach is currently of limited practical application; however, it merits future research.
- Placement of a layer of glycerine on the surface of the composite resin after initial photo-polymerization and further polymerization for 20-40 seconds (depending on the output of the polymerization light) at a distance of 1mm.

The 5 Phases of Gross Finishing

The function of the gross finishing phase is to remove any flash or overhangs from the margin to ensure the restoration finishes at a 90-

degree butt joint, to create an anatomical “peripheral rim” to facilitate interproximal oral hygiene measures and correct occlusal scheme, and to adjust and optimize the occlusal scheme.

The gross finishing procedure proceeds in the following 5-phase manner:

PHASE 1. An aluminum oxide course grit, medium-sized (1/2-inch) finishing disc is worked over the mesial and distal marginal ridges and cuspal inclines at an angle of around 45 degrees to the long axis of the tooth.

The disc is run at 5,000-15,000 RPM with or without a water spray. Prefer lower speeds without a water spray because it enhances visibility and precision. The shaping is conducted in bursts to avoid overheating the enamel resin interface. The assistant will copiously wash with an air-water spray from a 3-in-1 syringe between each burst to improve visibility and cool the restoration.

The restoration should be finished in a direction from composite resin to tooth structure to reduce the creation of marginal gaps and defects.

The aim of this phase is two-fold:

1. Creating a rounded mesial and distal marginal ridge contour, which is more esthetically pleasing, allows improved interdental cleaning without snagging of floss, and enables the creation of a more ideal occlusal scheme (since space is created for the opposing cusp tip).
2. Removal of marginal excess resin to form a 90-degree butt joint between resin and tooth structure. A butt joint is preferred since it is mechanically superior. If excess flash remains and the patient occludes on the flash, it will fracture in short order, leaving a marginal defect.

The patient presented with a failing Class 1 silver amalgam restoration and Class 2 caries. The tooth was isolated with a rubber dam.

After tooth preparation, bonding, and resin placement. (Note some resin flash is visible at the mesial box axial walls.)

PHASE 2. The gingival margin of the Class 2 box (if appropriate) is then finished with a diamond metal strip. Even with excellent matrixing and wedging, a small amount of flash/bonding agent remains. If left in situ, it can result in oral hygiene issues, periodontal problems, or secondary caries.

It is a simple matter to smooth this area with a coarse and medium grit metal strip. Be sure the strip goes apical to the contact point before actively removing excess resin so that the contact point is not inadvertently removed.

PHASE 3. The axial (vertical) margins of the Class 2 box are then planed using either a Number 12 (curved) scalpel blade or a heavy curette type scaler. This should be used in a scaling motion with a firm finger rest. Take care to plane parallel to the margin rather than at 90 degrees to avoid creating negative margins. These phases are all conducted with the rubber dam in situ for efficiency and to avoid iatrogenic damage to the patient's tissues. The dam is then removed.

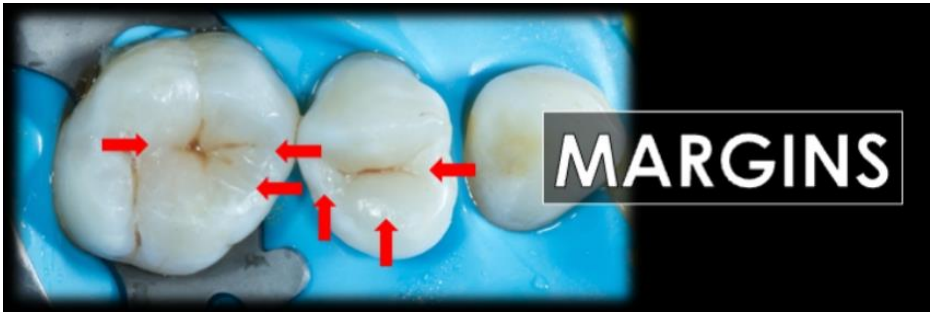
PHASE 4. Occlusal adjustment in MIP and all excursions are conducted with the operator's burr of choice and articulating paper. I tend to employ a small round diamond burr in a 1.5 speed increasing handpiece with a water spray at around 5,000-10,000 RPM.

PHASE 5. The margins and cuspal inclines are now smoothed with a coarse diamond-impregnated silicone point (e.g., Venus Supra, Kulzer). The aim is to eliminate flash and remove scratches created by the diamond burr during occlusal adjustment. The point is run at 8,000-10,000 RPM with a water spray to improve visibility, reduce thermal damage to the margin and increase the lifespan of the point. Light pressure should be employed.

Diamond-impregnated silicone points.

By following this sequence, the gross finishing stage should be completed in two to three minutes per unit.

Removal of flash and creation of a butt joint margin is illustrated in the following clinical sequence.



Class 1 restorations were placed in the first molar and second premolar teeth. Flash at the margins is visible (highlighted with red arrows).

The margins are finished with coarse silicone polishing points.

Margins after gross finishing.

Final Polishing of Direct Posterior Composite Restoration

The final polish stage aims to create a smooth “enamel-like” surface luster that is comfortable for the patient's soft tissues, is aesthetically pleasing, and resists staining and discoloration. This is accomplished in four phases.

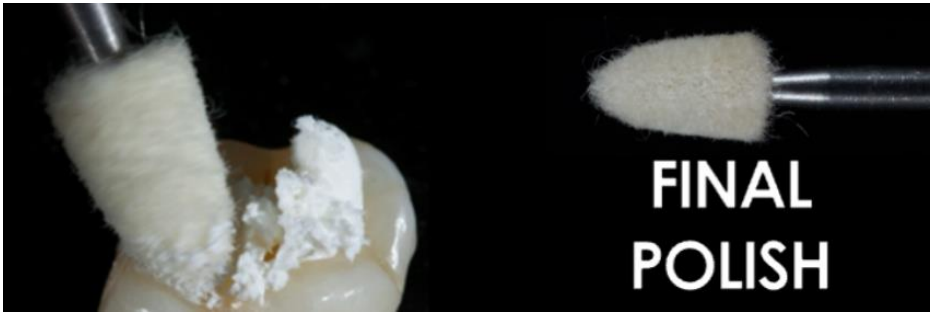
PHASE 1. Fine and superfine medium-sized finishing discs are used at a speed of 10,000-15,000 RPM to polish the peripheral rim. The discs should be used on the backhand at an angle of 45 degrees to the long axis of the tooth. (Do not default to the superfine disc until the fine discs have removed all visible scratches in the restoration.) If access is challenging (e.g., the distal marginal ridge of a second molar), consider employing a small-sized disc (3/8 inch) to avoid unintentional damage to adjacent soft tissues. I prefer to default to a medium-sized disc if this can be used safely because the larger disc cuts more efficiently and is less likely to create gouges within the restoration.

PHASE 2. A fine diamond-impregnated silicone point with water spray should be used to polish the margins and cuspal inclines of the restoration. This is to enhance the gloss of the restoration—the scratches should have been removed during the gross finishing phase.

PHASE 3. A goat hair brush (e.g., Shiny S) should be used with firm pressure and no water spray to polish into the fissure system of the restoration. The brush is used with a pumice paste (Vertex® Pumice Plus). This eliminates scratching within the fissure system, which tends to stain in the mid-term.

PHASE 4. The final gloss is created with a 1-micron aluminum oxide water-based polishing paste (e.g., Enamelize®, Cosmedent) and felt points and wheels. These are used at progressively increasing speeds (3,000-20,000 RPM) and decreasing pressure. The paste should be placed on the tooth/restoration rather than the disc to avoid scattering the paste throughout the operatory.

Polishing paste is applied.



Final polish is performed.

The tooth is then washed with an air-water spray, and the patient is dismissed.

Topic 12. Restoration crown's part of the tooth after endodontic treatment. Features of layered restoration.

Direct restorations for endodontically treated teeth. Direct restoration with composite resins is mainly indicated for teeth with minimal to moderate loss of tooth structure. The amount of remaining tooth structure is crucial for success. Resin-based composite (RBC) restoration allows for adhesive bonding to the tooth substrate.

Adhesive indirect partial restorations. Partial restorations are advantageous in preserving the sound tooth structure as well as providing cuspal coverage to protect the weakened cusps.

Post and core restorations for endodontically treated teeth. ETT with moderate-to-extensive loss of tooth structure often require post and core restorations for retention of the crown. The amount of remaining coronal tooth structure is an important factor in postselection.

Endocrowns. The use of intraarticular posts to rehabilitate ETT is associated with additional removal of sound tooth structure for postplacement with increased risk of catastrophic failure of the tooth. This occurs due to altered biomechanics of post and core treated teeth which concentrates stresses at the cervical third (for fiber posts) and at the apical thirds (for metal posts). A post less alternative to restore teeth is an “Endocrown.”Endocrowns are ceramic monoblock, which are adhesively luted to the internal portion of the pulp chamber and to the cavity margins of an endodontically treated tooth. This allows for a macromechanical retention provided by the walls of the pulp chamber as well as micromechanical retention provided by the cavity margins which are in enamel.

Onlays. Adhesive onlays are used to partially cover cusps, but not the entire occlusal surface. They are indicated for the restoration of ETT in the presence of at least one marginal ridge with two well-supported axial walls in continuity with the marginal ridge.

Overlays. Overlays are indicated for total cusp coverage for mesio-occlusal distal cavities, with loss of both the marginal ridges. These adhesive restorations require 50% less reduction of tooth structure, compared to complete crown restorations. Partial restorations

in the form of overlays allow the preservation of sound tooth structure while providing cuspal coverage to protect the weakened cusps.

Direct or indirect onlays can be used when the residual tooth structure is not undermined and the marginal ridges are intact. Use of overlays and full coverage crowns restrict cuspal displacement and are indicated in teeth with inadequate coronal tooth structure.

The choice of final restoration depends on the amount and quality of remaining tooth structure, topography and coronal morphology of the tooth and the functional occlusal forces that the restoration-tooth complex has to withstand.

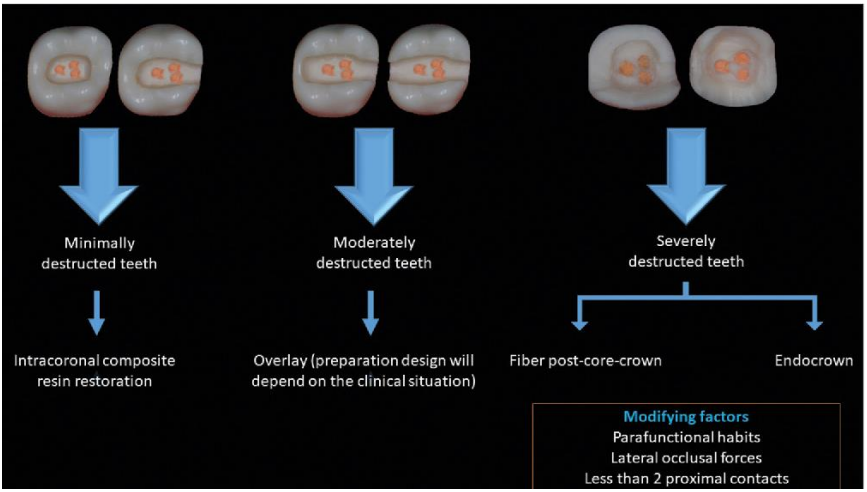
The classification sets the posterior teeth into one of the three categories depending on the amount of tooth structure lost. The three categories were referred to as minimally destructed teeth, moderately destructed teeth, and severely destructed teeth.

Minimally destructed ETT were defined as teeth with an occlusal cavity or a MO/DO cavity with thick remaining axial walls (≥2 mm). This category of teeth does not necessarily require cuspal coverage to have good longevity 78% survival rate over 5 years. Good survival rates for endodontically treated premolars with minimal MO/DO cavities were reported over 3 years without the need for cuspal coverage.

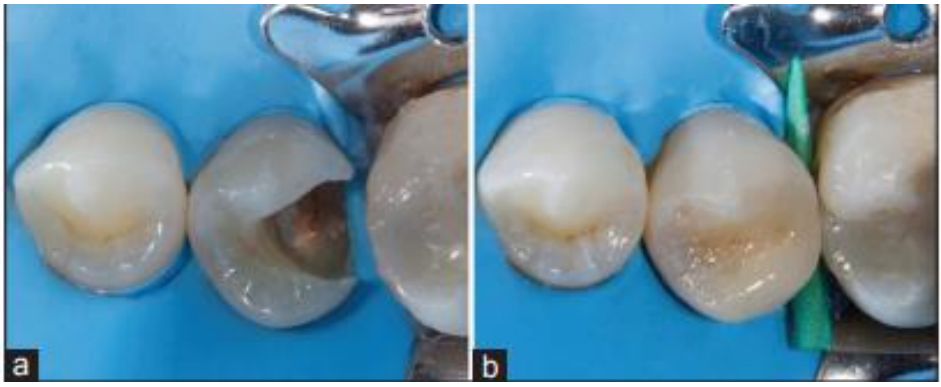
Moderately destructed ETT were defined as teeth with a MO/DO cavity with thin remaining axial walls (<2 mm) or a MOD cavity. The teeth in this category have reduced fracture resistance due to the amount of tooth structure lost and would probably benefit from cuspal coverage.

Severely destructed ETT were defined as teeth with tooth structure loss beyond a MOD cavity.

Flowchart for the decisionmaking process for restoration of posterior endodontically treated teeth using adhesively retained restorations



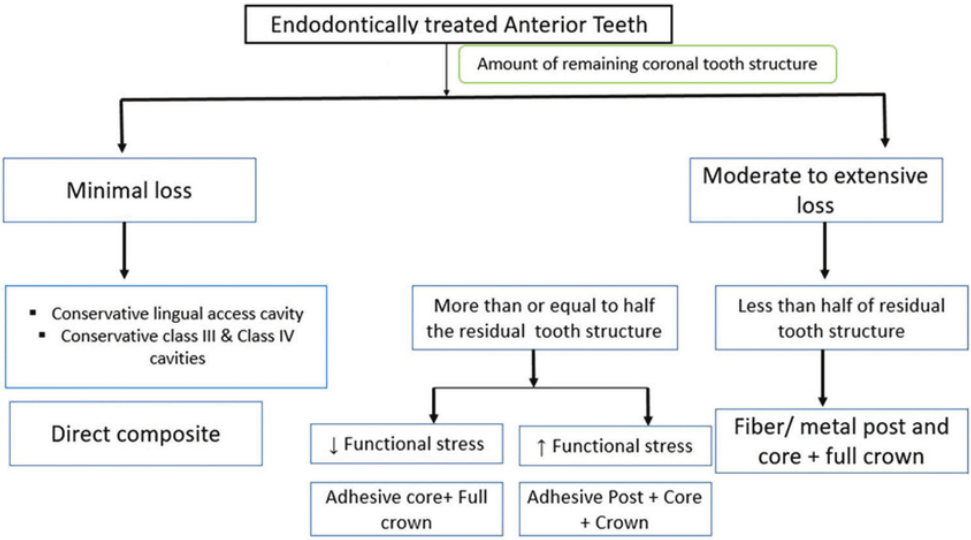
An example of the assessment and management of minimally destructed premolar tooth. (a) Clinical assessment of the endodontically treated mandibular second premolar revealed a distoocclusal cavity and axial walls thickness (≥2 mm). This tooth was categorized as minimally destructed tooth. (b) In the absence of any modifying occlusal factors, the minimally destructed mandibular second premolar was restored with an intracoronal composite resin restoration.



An example of the assessment and management of moderately destructed molar teeth. (a) Assessment of the amount of remaining tooth structure of the mandibular first and second molar teeth categorized them as moderately destructed teeth. (b) Following

composite resin core buildup, preparations for two adhesive overlays were carried out. (c) The moderately destructed mandibular molars were restored with indirect adhesive ceramic overlays.

An example of the assessment and management of severely destructed molar tooth. (a) Assessment of the amount of tooth structure loss of the mandibular first molar categorized it as a severely destructed tooth. (b) Pulp floor was sealed, and a conservative preparation for an endocrown was carried out. (c) Preparation for the endocrown bonding procedure under rubber dam isolation. (d) The endocrown bonding procedure to mandibular first molar. (e) The endocrown 1 week following the bonding procedure to the mandibular first molar.


Endodontically treated Anterior Teeth
Amount of remaining coronal tooth structure
Minimal loss
Moderate to extensive loss
Conservative lingual access cavity
Conservative class III & Class IV cavities
Direct composite
More than or equal to half the residual tooth structure
Less than half of residual tooth structure
↓ Functional stress
↑ Functional stress
Adhesive core+ Full crown
Adhesive Post + Core + Crown
Fiber/ metal post and core + full crown

Topic 13. Composite restorations on post. Types of posts. Indications for use. Methods of placing posts. Restoration crown's part of the tooth with posts.

Criteria for post placement

Anterior Teeth. If a crown is not required for esthetic or functional reasons, then it is generally considered unnecessary to place a post. The potential for root weakening from post preparation tends to outweigh any possible benefits. Uncrowned anterior teeth with access restoration and no post provided greater resistance to fracture under cyclic loading in vitro than even crowned teeth with post-core restorations. Optimally bonded composite restorations are appropriate. Intra-coronal and/or extracoronal bleaching can be considered for the relatively sound, but discoloured, anterior tooth to avoid the need for extra-coronal tooth preparation. The risk of resorption due to use of intra-coronal bleach can be prevented by placing a resin modified glass ionomer restoration at the base of the pulp chamber to prevent leakage to the periodontal ligament.

If a crown is necessary, due to the loss of external tooth structure, then a post is usually required for anterior teeth, due to the predominantly shearing forces present and the narrow tooth dimensions. Extra-coronal crown preparation combined with endodontic access preparation significantly weakens the cervical area of anterior teeth. The amount of tooth structure remaining and the particular functional demands will determine the absolute need.

Large, bulky anterior teeth with minimal access preparation may not require a post. If the situation is in doubt, it is better to complete the crown preparation first to allow complete assessment of the remaining tooth structure. Where the strength of the remaining tooth structure is borderline, then a post is indicated.

Posterior Teeth. Crowns, or some type of cusp coverage, are recommended for posterior teeth due to the high risk of catastrophic tooth fracture. The coronal-radicular restorative requirements however differ between molars and bicuspids.

General Guidelines for Post Placement

Anterior teeth

◆ If no crown is required, a post is generally unnecessary.

◆ If a crown is necessary, a post is generally required.

Posterior teeth (crowns generally required).

◆ Molar teeth with an adequate pulp chamber do not require a post.

◆ Molar teeth with inadequate pulp chamber may require a post.

◆ Maxillary bicuspids generally require a post.

◆ Mandibular bicuspids require independent consideration.

Types of Posts

Posts are classified into different categories as follows:

Active or passive posts.

Active posts are characterized by the presence of threads which when applied into the root canal can engage the walls of the canal and give the highest retentive effect, while *passive posts* are retained into the canal using luting cement. Active posts give more retention than passive posts, but due to stress existing within active posts, they may lead to root fracture and this is not found in passive posts. Hence, the use of active posts is preferred to be limited to short roots, in which a maximum retention is needed.

Tapered or parallel posts.

Parallel posts are more preferred than *tapered posts* due to many factors: parallel posts are more retentive than tapered posts, stress existence is less with parallel posts than tapered posts, and as in parallel posts, there is a less wedging effect and so less liable to cause root fracture rather than tapered posts. On the other hand, tapered posts need least dentine removal from the canal as most of the canals are tapered so more preservation of the tooth structure.

The material of the post:

1. Metal posts.

Prefabricated metal posts: It is considered as the most used posts by the dentists due to its simplicity; it needs short time for application into the root canal, in which all preparation steps of the root canal for creating space for the post and post. These types of posts can be fabricated from different types of metal alloys such as titanium and copper. Titanium posts are more preferred than other types due to its biocompatibility and high strength resisting the occluding forces and its decreased liability to fracture. On the other hand, metal posts are

difficult in removal from the canal if retreatment is needed, and also, it is difficult to be differentiated radiographically from the gutta-percha due to their same radiopacity.

Cast metal posts: This type of post is highly successful and gives excellent results. In addition, it has an advantage of simplicity in removal from the root canal if retreatment is needed. On the other hand, it has some disadvantages that make its use difficult and limited like; it is more expensive than prefabricated posts, many visits from the patient are needed because it needs to be sent to the laboratory, and contamination of the root canals may occur due to longer preparation time and multiple visits.

2. Fiber posts. Fiber posts are considered as an excellent type of posts due to its excellent characteristics and simplicity. In addition, it has a modulus of elasticity similar to the modulus of elasticity of dentine that makes it perfect in stress force distribution and so decreases the occurrence of root fracture. It contains either carbon fibers or quartz fibers that strengthen the root when used with the luting cement in the root canal. In retreatment cases, carbon fiber posts are easier in removal by ultrasonic drill than quartz fiber posts. On the other hand, the high flexibility of the fiber post makes it liable to move under the occluding forces leading to leakage and contamination of the root canal.

3. Ceramic and zirconium posts. This type of post is considered as the highest esthetic posts which are used in teeth where esthetic is highly required, especially, in the anterior teeth to avoid discoloration appearance. On the other hand, these posts are very difficult in removal from the root canal in retreatment cases and its removal can be only with burs that make a risk of root perforation.

Topic 14. Approaches to the correction and replacement of defective composite restorations: choice of method, advantages, and disadvantages of the applied approaches.

3Rs of minimal interventional operative dentistry:
1. Refurbishment: refinishing/resurfacing.
2. Repair.
3. Replacement

There are, in general, four approaches to the management of defective restorations, as follows:

- no treatment (monitoring), indicated if only minor shortcomings, eg, unfavorable color/staining or suboptimal margins are present, with no clinical disadvantages if untreated
- refurbishment, indicated if shortcomings may be corrected without damage to the tooth, eg, removal of overhangs, recontouring the surface, removal of discoloration, smoothening or glazing of surface, including sealing of pores and small gaps, without adding new restorative material (except glaze or bonding)
- repair, indicated mainly in the event of localized shortcomings that are clinically unsatisfactory and no longer acceptable; repair is a minimally invasive approach that implies in any case the addition of a restorative material (not only glaze or adhesive), with or without a preparation in the restoration and/or tooth structure.
- replacement, indicated if generalized or severe problems and intervention are necessary, and a repair is not reasonable or feasible; replacement is the complete removal of the restoration, usually involving more loss of tooth structure.

Restorations are replaced due to:
1. Primary and recurrent caries.
2. Poor margins.
3. Fracture of restorations.
4. Tooth structure fracture.
5. Poor esthetics due to discoloration.
6. Degradation of restorations.
7. Tooth structure loss due to attrition, abrasion, abfraction, and/

or erosion; and around the restoration which causes tooth pain/ sensitivity.
8. Secondary caries.
9. Material failures.
10. Marginal degradation.
11. Discoloration.
12. Loss of anatomic form.

Each time a restoration is replaced:

- The cavity becomes larger since it sacrifices the sound tooth structure (often distant from the site of restoration deterioration), hence tooth gets weaker.
- Reduces the likelihood of continuing pulp vitality.
- The restoration may become more complex. d. Adjacent teeth may be damaged.
- New defects may be introduced.
- Cost of the treatment will increase.
- An increased risk of failure.

Repair has following benefits over replacement:

1. Reduced risk of iatrogenic damage hence, less loss of tooth structure, more preservation and conservation of tooth tissue.
2. Reduction of potentially harmful effects to the dental pulp.
3. Reduction of pain, mostly no need for local anesthesia if repair is not extensive.
4. Often less risk of iatrogenic damage to adjacent teeth.
5. Reduction of treatment time and resources.
6. Reduced costs to the patient.
7. Good patient acceptance, patient centered treatment.
8. Increased longevity of the restoration
9. Opportunity for enhanced patient experience.

Repair procedures

The clinical procedure for the repair of a direct resin composite restoration with one or more limited defects is as follows:

- local analgesia, as indicated clinically
- removal of the defective part of the composite restoration and any adjacent secondary caries
- ensuring adequate moisture control; this can best be achieved with a

rubber dam or judicious use of cotton wool rolls and salivary ejectors; either way, it is essential to protect the preparation from contamination

- pulp protection, if indicated, according to contemporary regimes
- preparation of the composite substrate using an intraoral sandblaster or a fine grit diamond bur; any exposed tooth tissue should also be prepared by sandblasting, or with a fine grit diamond bur to ensure removal of any residual composite, let alone pellicle to provide a fresh surface to bond onto; the CoJet sandblaster utilizes silica particles and provides a microretentive, "silicatized" surface which, albeit not always necessary, may offer advantages in the repair strengths of the repair composite to the composite substrate
- the prepared composite substrate must be acid etched together with the preparation margins for 15–30 seconds and then gently washed and dried using a three-in-one syringe; in addition to producing a favorable substrate surface for bonding, acid etching has a cleansing effect.
- if the composite substrate has been treated with the CoJet sandblaster, apply a silane primer and corresponding adhesive (eg, ESPE Sil and Visio-Bond; 3M ESPE, St Paul, MN, USA) to the substrate and an adhesive bonding system to the adjacent tooth tissues and preparation margins, according to manufacturer's directions; if the substrate has been prepared with a fine grit diamond bur, an adhesive bonding system should be applied to the acid etched composite substrate and adjacent tooth tissues and preparation margins, according to the manufacturer's directions; alternatively, a commercially available composite repair system (eg, Ecusit-Composite Repair, DMG, Chemisch-Pharmazeutische Fabrik GmbH, Germany; Clearfil repair kit, Kuraray, Tokyo, Japan), which includes its own specifically formulated adhesive agent, may be used.
- apply resin composite restorative material using a 2 mm incremental technique to repair the defect; each increment must be polymerized using a visible light-curing unit; ideally, the same type and brand of resin composite material should be used as the composite substrate provided this information is known to the practitioner; the

composite substrate must be a minimum 2 mm in thickness for the repair procedure to be successful.

- carefully contour and finish the repair using contemporary composite finishing systems, to leave the repair integrated imperceptibly into the restored tooth unit
- check the occlusion and remove any occlusal interferences present.

Topic 15. The application of fiberglass splint in the practice of composite restoration of missing teeth.

Traumatic damage to anterior teeth is a common form of injury, particularly in children and adolescents.Conservative bridge preparation as the name suggests requires the minimal preparation of the abutment teeth and the fabricated bridge can be fixed to the adjacent natural teeth

Replacement of these teeth for the reestablishment of esthetic and function is challenging, since a previous bone loss would limit prosthetics treatment options, such as implant-supported restorations, removable partial denture (RPD), and fixed partial denture (FPD)

Conservative bridge preparation as the name suggests requires the minimal preparation of the abutment teeth and the fabricated bridge can be fixed to the adjacent natural teeth. Conservative bridges can be classified according to the type of pontic:

1. Natural tooth pontic
2. Denture tooth pontic
3. Porcelain fused to metal pontic
4. All porcelain pontic

In addition, they can be viable alternatives to conventional fixed bridges in circumstances when age, expense and clinical impracticality are considerations. These can also be used in the cases where there is a need for one-visit replacement of a single anterior tooth.

Resin-bonded bridge (RBB) is a conservative fixed partial prosthesis that provides esthetic and some functional demands, such as speaking, space maintenance, and lip support in anterior regions. RBBs are used to replace a single missed tooth, whereas the adjacent abutment teeth are sound and have enough enamel available for adhesion. In comparison to conventional FPD, RRBs need minimally invasive preparations and consequently cause less tooth sensitivity and less caries susceptibility. They also need fewer visits and have lower costs. In addition, RBBs can splint the mobile teeth where indicated, to improve patient comfort and spread occlusal forces across multiple abutment teeth.

If the tooth or tooth crown is still intact and the patient brings it with them to the dental office, it is easiest to use it as a natural tooth pontic, joining it to the adjacent teeth with an adhesive composite with

fiber reinforcement ribbon. When the tooth crown is not available, a denture tooth or a composite resin pontic can be shaped to fit the space of the missing tooth.

Techniques to replace a single missing anterior tooth by adhesive splinting using a natural tooth pontic, denture tooth, or composite resin tooth pontic embedded in wire, metal mesh, nylon, mesh, and cast metal. The inherent problems with these techniques have included lack of bonding between composite and metal or nylon, leading to fracture at the composite interface. Furthermore, to extend the durability of the restoration with submerged wires and mesh grids, composite resin had to be thick and bulky to minimize fracture. This thick and overcontoured restoration led to an increase in food and plaque retention and difficulties in maintaining periodontal health.

Resin-bonded maxillary natural tooth pontic. A, Preoperative photograph before extraction of periodontally involved maxillary right central incisor. B, Extraction site immediately after the removal of an incisor. C, Enlarged apical opening ready to be filled with composite. The pontic tip has been contoured to an ovate design. D, The abutment teeth are isolated, roughened, and acid etched. E, Immediate postoperative photograph of natural tooth pontic bonded in place. F, Resin-bonded natural tooth pontic with healed residual ridge 6 weeks later.

A and B, Anterior resin-bonded bridge with multiple pontics. Before and after views of a porcelain-fused-to-metal, resin-bonded bridge replacing both maxillary central incisors.

Ribbond (Ribbond, Seattle, WA, USA) is made from an ultrahigh modulus, ultrahigh molecular weight polyethylene fiber that is woven into a porous ribbon. It is biocompatible, inert, colorless, and translucent. The combination of the fiber material and the bi-directional weave makes the ribbon exceptionally pliable and compliant.

Conservative Bridge Preparation: With Ribbond Fiber

Indications

1. Replacement of missing anterior teeth in children and adolescents
2. Short span edentulous areas
3. Unrestored abutments
4. Single posterior tooth replacement
5. Significant clinical crown length
6. Excellent moisture control

Contraindications

1. Parafunctional habits
2. Long edentulous spans
3. Restored or damaged\abutments
4. Compromised enamel
5. Significant pontic width discrepancy
6. Deep vertical overlap

Advantages

1. Minimal removal of the tooth structure
2. Minimal potential for pulpal trauma
3. Anesthesia not usually required

4. Supragingival preparation
5. Easy impression making
6. Interim restoration not usually required
7. Reduced chair time
8. Reduced patient expense

Replacement of Missing Anterior with Maryland Bridge using Ribbond

FRC resin bridge with composite was given for the purpose of aesthetic concern of the patient in the mandibular anterior region until a fixed prosthesis can be planned.

Pre-operative picture

Etchant application

Bonding agent applied

Bonding agent cured

Ribbond placed horizontally connection 31 and 41

Ribbond placed vertically over the horizontal segment

Post-operative picture after composite buildup

This technique have several advantages because it does not require any tooth reduction and could be repaired, modified or removed from the abutment teeth without any damage to the sound tooth structure. Also, resin bonded bridges can be highly effective, as they help in restoring oral function, aesthetics and result in high levels of patient satisfaction. Careful case selection, thoughtful design planning, precise preparation and a careful cementation program can all ensure the long-term success of Maryland Bridges, making them ideal treatment option for temporary replacement of individual missing anterior teeth.

Digital technique for fabricating resin-bonded splinting fixed partial dentures (S-FPDs).

The technique is described for a 45-year-old female patient who had a chief complain of mobile mandibular anterior teeth as well as tooth missing.

It restores the missing mandible anterior teeth and splints the adjacent periodontally mobile teeth of the patient at the same time. The S-FPDs is designed and fabricated by computer-aided design and computer-aided manufacturing (CAD/CAM) technology with flexible PMMA material.

In this case, partial fixed dental prostheses and periodontal splint combine together, acting as a medium-term provisional restorative treatment method. Extracted teeth and composite resin have been used for pontics allowing immediate esthetic recovery, while loose adjacent teeth have been reinforced with splinting.

Clinical situation after initial periodontal therapy.

The resin-bonded splinting fixed partial dentures (S-FPDs in short) technique was used as follows:

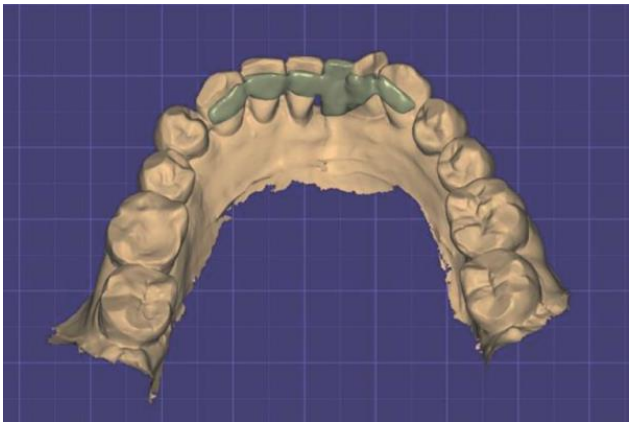
1. Get the digital model.

2. Design the restoration.

Intraoral scan of both dentitions

3. Fabricate the restoration.

CAD-CAM procedure.



4. Cement the restoration

Apply a bonding primer on the intaglio surface of the restoration and light cure. The lower anterior teeth were isolated by rubber dam. The enamel surfaces on the lingual side were subsequently etched with 35% orthophosphoric acid for 60 seconds. After rinsing with water and air drying, the corresponding intermediate adhesive was applied to the surfaces using a micro-brush and light cured for 10 seconds. Cement the S-FPDs with adhesive resin cement (RelyX™ Ultimate, 3M ESPE).

5. Finishing the restoration.

Immediate after cementation.

Fiberglass Splinting is a biocompatible alternative to splints with metal retainers. fibers are particularly suitable for all kind of dental splints, as for example stabilization of teeth which are mobile due to trauma, or loose teeth resulting from periodontal disease. They are indicated also for temporary repositioning of extracted front teeth and / or for teeth reconstructed in composite.

Clinical applications of fiberglass strips

- Periodontal Splinting
- Splinting after periodontal surgery
- Temporary solution while waiting for an implant

Topic 16. A synergy of function and aesthetics to achieve a successful result of aesthetic dental restorations.

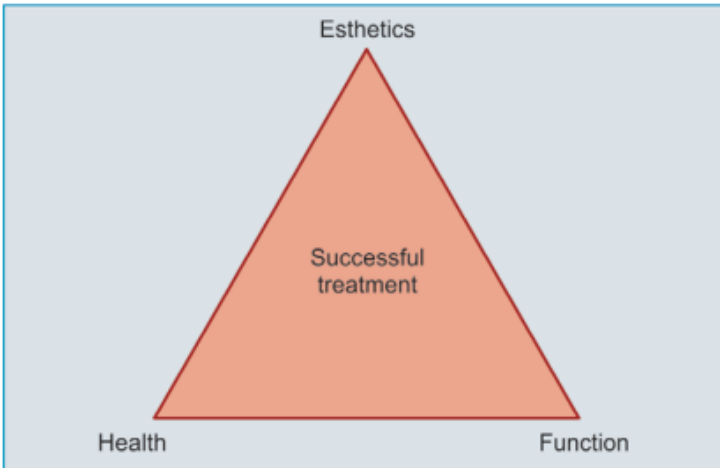
Goal of operative care is achieved by attaining health, function and esthetics. It is also known as health, function and esthetic triad (HFA).

Elements of dental esthetics

Following basic elements should be considered to achieve optimal esthetics:

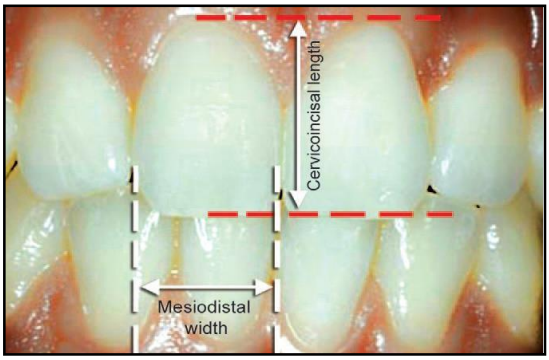
- Size, shape and width of teeth.
- Symmetry and proportionality of teeth.
- Alignment of teeth.
- Contacts and embrasure form.
- Gingival esthetics.
- Facial proportions.
- Color and translucency.

HFA triad for achieving optimal treatment



1. Size, Shape and Width of Teeth. It is determined by dividing of mesiodistal width of tooth to cervicoincisal length.

Size of tooth = Width/length ratio. To have optimal dimension, width/length ratioof central incisor should range from 0.75 to 0.8.



Ideal ratio 0.75 to 0.8

•<0.75 – Narrower tooth

•>0.8 – Wider tooth

Size of body is visible according to the light reflected from it. It controls width and length, which appears to a viewer. When a tooth is highlighted upon direct light, then area of depression is shadowed. Tooth size and appearance can be changed by creating different prominences on facial surface. These illusions are useful for creating apparent size of tooth different from actual size. These concepts are important in correction of diastema, smile designing cases.

Shape of Teeth.

It is determined by age, sex and personality of the individual. A young and feminine smile shows teeth with rounded incisal angles, open incisal and facial embrasure. while a masculine smile shows closed incisal embrasures with prominent incisal angles. If in females slightly broader teeth are present, they require conservative minor modification to produce better esthetics. This is called ‘cosmetic contouring’. To create younger and more feminine smile, incisal angles are rounded and incisal embrasures are opened.

Thickness of Teeth.

Labiolingual thickness of anterior teeth is measured at the junction of middle and incisor third of tooth. Ideally, it should be between 2.5 and 3.5 mm. Minor positional defects can be treated by composites or facial

veneers but major defects in position and alignment are corrected by orthodontic treatment.

2. Symmetry and Proportionality of Teeth.

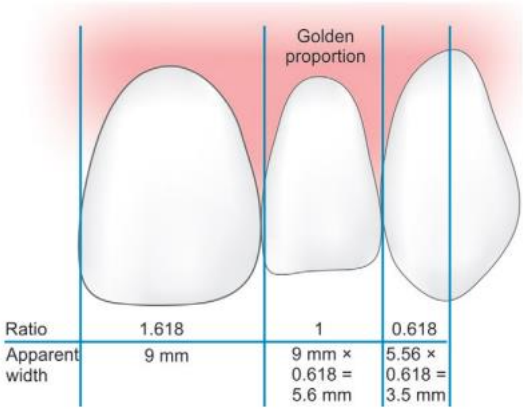
Symmetry.

Dental symmetry is achieved if contralateral teeth are placed equivalent. Restoration of teeth should be done carefully for symmetrical incisal and gingival embrasure.

Proportion.

The term "golden proportion" is a mathematical rule concerning the proportions of the dentition. This concept was firs given by Lombardi and Levin. According to this rule, if the width of each anterior tooth seen from frontal view is approximately 60% of the size of its adjacent anterior tooth, then it is considered esthetically pleasing. It follows logically that if the width of the lateral incisor is 1, the central should be 1.618 times wider and the canine 0.618 times narrower.

Rule of golden proportion. If apparentsize of each tooth is seen from frontal view, 62% tooth size anterior to its relationship is considered esthetically pleasing.



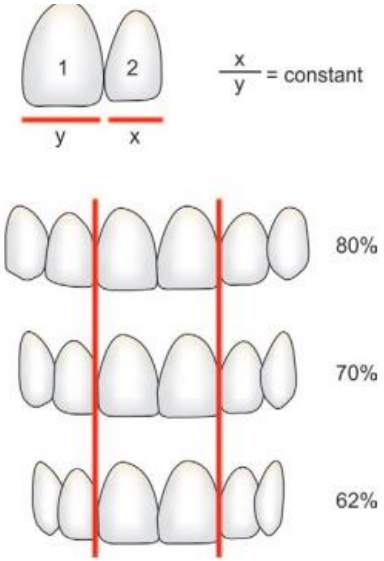
3.Tooth Alignment.

A line extending from height of the tooth from free gingival margin to center of the incisal edge implies axis inclination of each tooth. Maxillary anterior teeth display mesio-axial inclination, with the central incisors appearing to be almost vertical, lateral incisors and canines

tipping more towards midline. After canines, the posterior teeth display an inclination that is parallel to canines.

RED proportion states that the width of the teeth as viewed from frontal should remain constant as one moves distally instead of using 62% proportion.

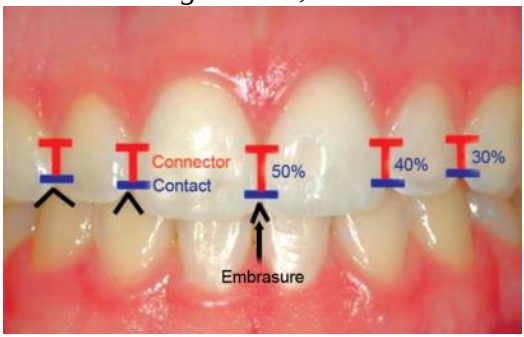
Schematic representation of RED proportion



4. Contacts and Embrasure Form.

Exact place where a tooth touches other tooth is called a contact. (also referred as interdental contact area). The length of this area is not the same between the incisors. The longest contact area is between the central incisors; the shortest contact is between the lateral incisor and the canine. As teeth proceed from midline to posterior, the contact points move apically. The triangular space incisal to the contact area defined as embrasures. Embrasure area gets larger as the teeth progress posteriorly.

Clinical picture showing contact, connector and embrasure



5.Gingival Esthetics (Shape and Contour). Cementoenamel junction and osseous crest determine the curvature of gingival margin of tooth, called gingival shape. Mandibular incisors and maxillary laterals have oval and maxillary centrals and canines have elliptical gingival shape.

Gingival zenith represents the most apical point at which each tooth emerges from the free gingival margin. For an esthetically pleasing smile, it should be positioned distal to center of each tooth in maxillary anterior segment. Gingival zenith of maxillary laterals should coincide with their longitudinal axis.

Usually, the zenith points of the lateral incisors are 0.5 to 1 mm below those of the central incisors and canines, while the zenith points of the canines and central incisors remain on the same horizontally drawn imaginary line.

6. Facial Proportions. Facial composition is measured by analyzing the face from frontal and sagittal aspect. From frontal aspect, many landmarks are used to determine esthetics. Horizontal lines are drawn from upper to lower part of face; these are hair line, interpupillary,

interalar and commissural lines. Parallelism of these lines results in horizontal symmetry of the face. The interpupillary line is used as a reference for the occlusal and incisal plane orientations. The incisal edges of the anterior teeth should be parallel to the interpupillary line and perpendicular to the midline.

From sagittal aspect, two reference points are used that is nasolabial angle and Rickett's E-plane. Nasolabial angle is formed by intersection of two lines using nose and lips as reference points. Normal value of nasolabial angle for males is 90 to 100 and for females is 100 to 105°.

Rickets E-plane is line drawn from tip of nose to chin prominence. Using these two reference points, protrusion or retrusion of maxilla can be evaluated.

7. Lip line. When smiling, the inferior border of the upper lip as it relates to the teeth and gingival tissues is the lip line. Dentistry has arbitrarily classified three types of smiles that, relating the height of the upper lip relative to the maxillary anterior central incisors, which are referred to as presenting a low lip line, middle lip line, high lip line.

• Average lip line-exposes the maxillary teeth and only the interdental papilla.

• Low lip line: exposes no gingival tissues when smiling.

• High lip line: exposes the teeth in full display also gingival tissues above the gingival margins.

In cases where there is a high lip line and an excessive gingival display exists, an unwanted (gummy smile) become evident.

There are many corrective options available. The vertical maxillary excess can be determined with cephalometric analysis. Orthodontics and orthognathic surgery to impact the maxilla are ideal when these conditions are confirmed as skeletal dysplasias in nature.

The smile line. The smile line is an imaginary line running from the incisal edges of the maxillary incisors and coinciding with the curvature of the lower lip.

8. Color and Translucency.

Color is defined as property of surface or object as a result of absorption of certain light rays and reflection of others, which excite the photosensitive receptors of an eye. There are different color combinations, which help the dentist to select the most appropriate

color matching with the tooth or teeth in patient. Munsell color system is most commonly used visual color system. It consists of the parameters, which are represented in three dimensions:

- Hue is the name of the color (color tone (red, green, yellow).
- Chroma represent the saturation or the intensity of color.
- Value corresponds with the lightness or darkness of the color.

Translucency.

Degree of translucency means how deeply light penetrates into the tooth or restoration before it is reflected outwards. The goal of an optimal restoration is to achieve the natural appearance of the tooth. Translucency indicates lifelike esthetic and vitality of natural teeth. The opaque, dead appearance of a restoration should be avoided. The incisal third of the tooth is more translucent than the middle and cervical thirds.

Many treatment options are available that can be employed to improve the esthetics of affected tooth/teeth:

1. Enameloplasty. It helps in improving minor changes in contour of tooth by removal of enamel. It is done to smoothen the roughened enamel margins, fractured tooth surfaces and to soften interproximal angles. Tooth is polished after ameloplasty.
2. Bleaching. Teeth with mild to moderate discolorations can be treated by bleaching (teeth whitening).
3. Restorations with Composite Resins. Composite resins are indicated for treatment of minor defects present on incisal edges or labial surfaces of teeth like caries, fracture, diastema, peg-shaped laterals, etc.
4. Veneers. Veneer can be described as a layer of tooth colored material which is applied on the tooth surface for esthetic purpose. Veneers are used to mask the intrinsic discolorations, localized and generalized defects.

Types of Veneers Based on method of fabrication:

a) Direct veneers (Composite veneer): Because of the possibility of etching the enamel and dentin, the clinician can bond resin composites directly to the tooth, using an incremental layering technique. This requires minimal or no tooth preparation and can be performed in one session without any laboratory costs.

b) Indirect veneers (ceramic veneers): When it became possible to etch the enamel with phosphoric acid and condition the cementation surfaces of the ceramics with hydrofluoric acid followed by silanization, ceramic laminates could be permanently bonded to teeth.

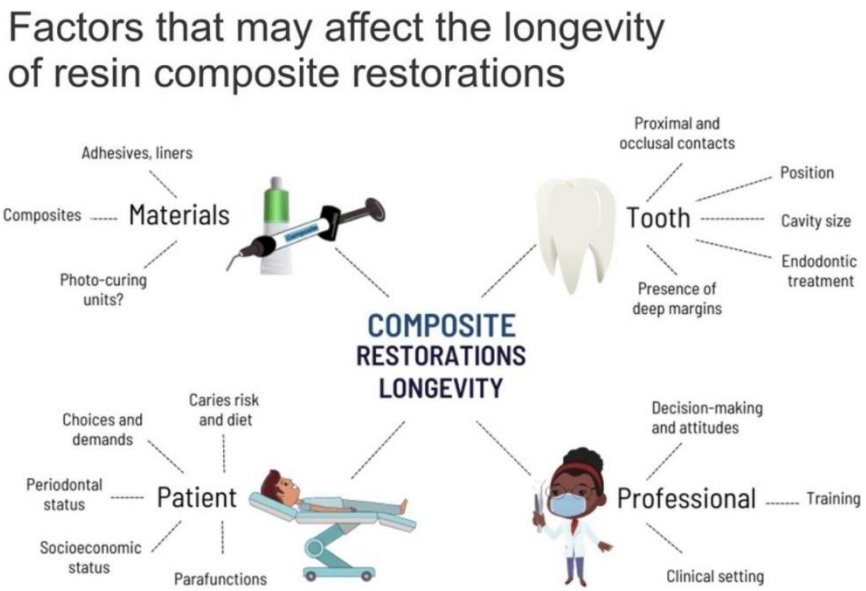
Indirect Ceramic Veneers Vs Direct composite veneers:

Ceramic veneers are stronger and more durable than direct composite veneers and have more color stability but they cannot be repaired easily and its color cannot be altered substantially after placement. Direct composite veneers can be done in single visit, as it not required laboratory procedures and it is more economic than indirect ceramic veneer.

5. Full Coverage Crowns: Full coverage restorations are required to increase the esthetics. These restorations can result in change in shape, size, and contour that remarkably change self-image of the patient.
6. Orthodontic treatment.

Topic 17. Biomechanics of the composite restorations' functioning. The concept of critical zones. Indicators of success and the main reasons for the failure of composite aesthetic restorations in the short and long term.

A number of risk factors are involved in the longevity of composite restorations. Differences between composites play a minor role in durability, assuming that materials and techniques are properly applied by dentists. Patient factors play a major role in longevity. The decision-making process implemented by dentists relative to the diagnosis of aging or failed restorations may also affect the longevity of restorations. Clinicians should treat patients comprehensively and promote a healthy lifestyle to ensure longevity.



Failures that can be seen in a composite restoration are as follows:

• Discolorations especially at margins.

• Marginal fractures.

• Recurrent Caries.
• Gross fractures of restorations.
• Lack of contact maintenance.
• Post-operative sensitivity.
• Pulpal irritation or damage.
• Microleakage around composites.

Aspects that influence longevity of composite restoration

1. Clinical factors.
2. Operator factors.
3. Patient factors.
4. Socioeconomic factors.
5. Material factors.

Clinical Factors

Extra oral

• Moisture contamination from hand piece or air water syringe.
• Oil contamination of hand pieces or air water syringe.
• Presence of bases or liners on prepared teeth.

Intra oral

• Salivary and or blood contamination.
• Surface roughness of tooth surface.
• Mechanical undercuts in tooth preparation.
• Fluoride content of teeth.
• Presence of plaque, debris, calculus, extrinsic strains or debris.
• Tooth dehydration.

Common problems associated with some composite restorations and potential solutions to those problems.

1. White Line Adjacent to the Enamel Margin. A white line adjacent to the enamel margin of a direct composite restoration is usually caused by a microseparation (space) between the composite and the tooth or a microfracture within the marginal enamel, either of which is typically caused by:

• Inadequate etching and bonding of the afected area.
• High-intensity, fast light curing resulting in excessive polymerization stresses.
• Traumatic inishing techniques.

Potential solutions are as follows:

• Use atraumatic finishing techniques (e.g., light intermittent pressure).
• Use proper polymerization techniques.
Some of these small defects may not be clinically relevant and can be monitored over time for signs of marginal deterioration.
However, often they need to be managed, as follows:
• Seal the gap with adhesive.
• Conservatively remove the defect and re-restore.

2. Void.

Causes of voids include the following:
• Spaces left between increments during insertion (lamination defects).
• Adherence of composite to hand instruments during placement in the preparation, which is related to the previous item.
Potential solutions are as follows:
• Use a more careful restorative technique.
• Repair marginal voids by preparing the area and re-restoring.

3. Weak or Miing Proximal Contact (Cla II, III, and IV).

Causes of weak and missing proximal contacts are as follows:
• Inadequately contoured matrix band.
• Inadequate wedging, preoperatively and during the composite insertion.
• Matrix band movement during composite insertion or matrix band not in direct contact with the adjacent proximal surface.
• A circumferential matrix being used when restoring only one contact.
• Adherence of composite to hand instruments during insertion and resultant pulling away from matrix contact area.
• Matrix band too thick.
Potential solutions include the following:
• Contour the matrix material properly.
• Have the matrix in contact with the adjacent tooth.

4. Inaccurate Shade

Causes of an incorrect shade matching include the following:
• Inappropriate operatory lighting while selecting the shade.
• Selection of shade after the tooth has dehydrated.
• Shade tab not matching the actual composite shade.
• Wrong shade utilized.
Potential solutions are as follows:

• Use natural light when selecting shade, if possible.
• Select the shade before isolating the tooth.
• Place some of the selected shade on the tooth and cure preoperatively to verify shade selection.
• Do not shine the operator light (overhead or attached to operator loupes) directly on the area during shade selection.
• Understand the typical zones of different shades for natural teeth.

5. Contouring and Finishing Problem

Causes of contouring and/or finishing problems are as follows:

• Inadequate anatomic tooth form (overcontour or undercontour of the restoration).
• Improper selection of finishing instrument and improper composite placement.
• Iatrogenic damage to adjacent unprepared tooth structure.

Potential solutions include the following:

• Have a proper matrix with appropriate axial and line angle contours.
• Create embrasures to match the adjacent tooth embrasure form.
• Remember the outline form of the preparation.
• Use a properly shaped finishing instrument for the area being contoured.
• Be careful with the use of rotary instruments to avoid adversely affecting the structure of the adjacent tooth or teeth.
• Do not use rotary instruments that leave roughened surfaces.

6. Potoperative Senitivity. *Postoperative sensitivity can result from the following:*

• Aggressive tooth preparation (inadequate use of coolant systems, inefficient cutting instruments).
• Incorrect use of adhesive systems.
• Not using a liner/base when indicated.
• Formation of microgaps secondary to excessive polymerization shrinkage stress, particularly in situations of high C-factor.
• Aggressive finishing of the restoration.

Potential solutions include the following:

• Use careful tooth preparation technique.
• Use liners/bases properly.
• Use adhesive systems properly.

• Use a desensitizer solution after dentin acid etching.
• Insert and polymerize the composite material properly.
• Finish the composite restoration properly.

Factors affecting polymerization shrinkage

Configuration factor. Class 1 and class V cavity exhibit greatest stress because the restoration is bonded to five walls of the cavity. High C – factor results in debonding of the restoration. Lowest stress is seen in class IV cavity because it has enough unbonded surfaces providing stress relief. Hence it is important to have lower configuration cavity.

Composition of resin composites. A resin matrix with monomers of high molecular weight will result in lower shrinkage values than those formulated with monomers of low molecular weight. Molecular functionalities, molecular structure, molecular mass and size have major influences upon the amount of shrinkage and also on monomer viscosity.

Material properties. There are three inherent properties of the resin composites that are crucial over the magnitude of stress:i) volumetric shrinkage ii) material stiffness(elastic modulus) and degree of conversion from double bonds to single bonds

Filler volume fraction. Filler volume fraction is inversely proportional to volumetric shrinkage. As the volume of filler content increases, the volume of resin matrix decreases and hence volumetric shrinkage reduces proportionately.

Intensity of curing light. Higher the light intensity, greater the polymerization shrinkage. This is due to the greater degree of conversion. The slower polymerization retards the gel point, which provides time for stress relaxation.

Thickness of composite resin. Incremental curing produces lesser polymerization shrinkage stress than bulk curing.

Methods to minimize polymerization shrinkage.

Silorane based composite formulation. Silorane was synthesized by combining oxirane and siloxane molecules.Due to the ring-opening oxirane monomer the silorane-based resin possess the advantages of low polymerization shrinkage. These monomers produce circumscribed

volumetric expansion because of the opening of ring , which make up for the volumetric shrinkage.

Modification in the photo initiator systems. Increasing the inhibitor concentration reduces polymerization shrinkage without altering the final degree of conversion. Camphoroquinone substituted by phenylpropane Dione reduced the stress produced by polymerization.

Light curing techniques. These techniques reduce polymerization shrinkage by providing low rate of polymerization at initial stages which in turngives enough time for stress relaxation before reaching the gel state.

Soft start polymerization. In this technique, curing begins with low intensity and ends with high intensity. This offers advantage of stress relaxation before maximum possible conversion.

Soft start polymerization is subdivided into three techniques:

1) Staged cure.
2) Ramped cure and.
3) Pulse delay.

Staged cure/ delayed curing. The restoration is initially cured at lower intensity until the contour and shape of the restoration is achieved. The second exposure with high intensity is applied to cure the final restoration. This provides substantial stress relaxation period. The longer the relaxation period, lower the stress generated.

Ramped curing. The intensity is gradually increased during the polymerization process. It is achieved by increasing the intensity with every 30 seconds either by bringing the light closer to the tooth or using a curing light designed to change its intensity. This allows the light curing material to have a prolonged gel phase during which the polymerization stresses are distributed readily.

Pulse delay. In this method, each exposure is separated by a dark interval. During this phase the polymerization reaction takes place at a slow rate. The greatest reduction in the shrinkage is accomplished with the delay of 3 to 5 minutes. Curing done for 10 seconds at 1-cm distance with a time gap of 10 seconds followed by 20 seconds curing in contact with the tooth surfaceproves to be a suitable technique to reduce the polymerization shrinkage without compromising the degree of conversion.

Use of stress absorbing liners. The application of a low modulus flowable composite acts as a elastic buffer to compensates polymerization shrinkage stress by flowing readily into the cavity's line angles and irregularities. When elastic modulus is low, the composite will expand to adapt to the inherent modulus of the tooth. Flowable composite can be used as an intermediate stress absorbing layer as it reduces the stress at the tooth-restoration interface.

Resin-modified glass ionomer cements (RMGICs) may be a better alternative material to be used as a liner under resin composites as it reduces the amount of polymerization shrinkage, microleakage and secondary caries.

PLACEMENT TECHNIQUES

Incremental layering technique:

Incremental filling of composites decreases polymerization shrinkage stress as a result of reduced material volume. This method of incrementally curing resin-based composite ensure complete polymerization and helps to achieve better marginal seal thereby preventing distortion of the cavity wall.

The various placement techniques for composites based on incremental layering are:

Horizontal technique. It involves placement of composite material in an occlusogingival direction particularly used to restore small cavities. This layering technique increases the C-factor.

Three-site technique. This layering technique is performed with the use of a matrices and reflective wedges. It guides the vectors of polymerization towards the gingival margin preventing any gap formation.

Oblique technique. This technique involves placement of wedge shaped composite increments to prevent distortion of cavity walls. This method might be associated first with polymerization through the cavity walls followed by the occlusal surface to direct polymerization vectors towards the adhesive surface.

Successive cusp buildup technique. This technique involves the placement of first composite increment to a single dentin surface with no contact to the opposite cavity walls followed by restoration build-up by placing a series of wedge shaped composite increments.

Bulk technique. The bulk technique is used to reduce stress at the Cavo surface margins which is not supported by a recent study.
Preheating. Preheating increases composite flow, improves marginal adaptation and monomer conversion. Preheating causes temperature rise which reduces the viscosity and increases radical mobility resulting in the higher degree of conversion and additional polymerization.
Insertion of glass mega fillers. Inserting spherical glass mega fillers into the composite restoration before polymerization, will decrease the amount of resin matrix thereby reducing polymerization shrinkage. Its spherical shape does not hinder the flow ability of the composite during polymerization.

Keys to success of composite restoration

• Use the most conservative approach.
• Routinely employ adhesive procedures.
• Bevel the enamel margins.
• Use a layering technique.
• Obtain a proximal contact.
• Restore functional occlusal and proximal anatomy.
• Achieve good internal adaptation.
• Create a good integration with periodontal tissue.

Topic 18. Teeth whitening as a method of discoloration correction. Approaches, active agents, indications and contraindications, advantages and disadvantages.

Bleaching is a procedure which involves lightening of the color of a tooth through the application of a chemical agent to oxidize the organic pigmentation in the tooth.

Goal of bleaching is to restore the normal color of a tooth by decolorizing the stain with a powerful oxidizing agent, also known as a bleaching agent.

Mechanism of bleaching is mainly linked to degradation of high molecular weight complex organic molecules thatreflect a specific wavelength of light, that is responsible for color of stain. Resulting degradation products are of lower molecular weight and composed of less complex molecules that reflect less light, resulting in a reduction or elimination of discoloration.

Extrinsic pigmentations are usually produced on the surface of the tooth. The attraction of different materials to the tooth surface plays a critical role in the deposition of extrinsic pigmentations.

Such pigmentations can be classified into the following:

N1: type of direct dental stain with chromogenic bind to the tooth surface. The color of the chromogen is similar to that of the dental stains; such as stains by tea, coffee, wine, metals and bacterial products.

N2: type of direct dental stain with colored materials that change tooth color after joining the surface. Pigmented mate-rials are initially bonded to the surface of the tooth and then change the color. Typical example is yellow-pigmented plaque or coffee on inter-proximal or cervical areas.

N3: type of indirect dental stain with colorless materials or pre-chromogens that bind to teeth, carrying a chemical reaction that causes the dye to convert to chromogens and pre-chromogens, such as fluoride or chlorhexidine.

Most of the extrinsic pigmentations can be treated with mechanical or chemical coloring renewal techniques, and advising the patients about their habits and prevention mechanisms to avoid surface stains.

The intrinsic pigmentations are those that involve the thickness of the tooth, located in the enamel or dentin. They consist of deep pigmentation, and are difficult for therapeutic options or therefore constituting a clinical challenge to find a solution. This is the case of pigmentation by tetracycline, different degrees of "enamel hypoplasia", "fluorosis", "den-tinogenesis imperfecta", among others.

Contraindications

Poor Case Selection. Patient having emotional or psychological problems is not right choice for bleaching.

Dentin Hypersensitivity. Hypersensitive teeth need to provide extra protection before going for bleaching.

Extensively Restored Teeth. These teeth are not good candidate for bleaching because:

• They do not have enough enamel to respond properly to bleaching.

• Teeth heavily restored with visible, tooth colored restorations are poor candidate as composite restorations do not lighten, in fact they become more evident after bleaching

Teeth with Hypoplastic Marks and Cracks. Application of bleaching agents increases the contrast between white opaque spots and normal tooth structure. In these cases, bleaching can be done in conjunction with:

• Microabrasion.

• Selected ameloplasty.

• Composite resin bonding.

Defective and Leaky Restoration. Defective and leaky restorations are not good candidate for bleaching.

• Discoloration from metallic salts particularly silver amalgam: dentinal tubules of the tooth become virtually saturated with alloys and no amount of bleaching with available products will significantly improve the shade.

• Defective obturation: if root canal is not well-obturated, then refilling must be done before attempting bleaching.

Bleaching agents

Different types of bleaching agents are available commercially. These bleaching agents may contain the following components.

Hydrogen Peroxide

• Used in concentration between 5 and 35%.
• H_2O_2 has low molecular weight so can penetrate dentin and release oxygen.
• It is clear, colorless, odorless liquid stored in light proof bottles.
• Should be stored in dark and cool place (refrigerator). It is unstable and should be kept away from heat.
• If stored properly, its shelf life is 3 to 4 months but decomposes rapidly in presence of organic debris and an open air.
• Should be handled carefully to prevent direct contact with mucous membrane.
• Can be used alone or in combination with sodium perborate.

Sodium Perborate

• Available as white powder in granular form.
• Mainly three types: sodium perborate monohydrate, trihydrate and tetrahydrate.
• Three types vary in oxygen content.
• When mixed with superoxol, it decomposes into sodium metaborate, water and oxygen.

Carbamide Peroxide

• Also known as urea hydrogen peroxide.
• Used in concentrations ranging from 3 to 45%
• It decomposes into urea, ammonia, carbon dioxide, and hydrogen peroxide.
• Carbopol(polyacrylic acid polymer)is used as a thickening agent. It prolongs the release of active peroxide.
• For gel preparations, glycerine, propylene glycol, sodium stannate, citric acid and flavoring agents are added.

Bleaching techniques

• For vital teeth.
– Home bleaching technique/night guard vital bleaching.
– In-office bleaching:
  - Thermocatalytic.
  - Nonthermocatalytic.
  - Microbrasion.

• For nonvital teeth:
– Thermocatalytic in-office bleaching.

– Walking bleach/intracoronal bleaching.
– Inside/outside bleaching.
– Closed chamber bleaching/extracoronal bleaching.
• Laser-assisted bleaching.

Topic 19. Protocols of photo documentation during aesthetic restoration. Basic camera settings for recording the initial state of the dental status. Mirrors, retractors, and contrasters for high-quality photography. Features of macrophotography in dentistry.

For dental photography, you need a camera with a dedicated macro lens and flash. The equipment presented in these pages is intended to serve as a guide that can help with selection of similar products from other manufacturers.

The best results can be achieved with a digital single lens reflex (DSLR) camera. This type of camera has interchangeable lenses, providing great flexibility. To choose the proper body for dental photography, important elements to consider include size, weight, custom shooting modes, sensor type and size, built-in wireless controller, and manufacturer.

Ring Flash

Dual Flash

External Flash

For surgery, a ring flash is the top choice. Its compact size and the position of the flash tubes next to the lens makes it possible to perfectly illuminate all the areas in the limited space of the oral cavity.

A dual flash can also be used during surgical procedures, but essential in this case is the close position of the flash heads next to the lens axis. Such a position can be set on the dedicated mount ring for the specific flash models (Canon MT-24EX and Nikon R1C1) or with brackets.

A ring flash has more limitations for documenting prosthetic procedures. The straight direction of the light creates a “flat” picture flooded with light. The glossy surface of tooth enamel reflects the light, and the information on such a picture is limited (like color, transparency and texture). A better choice is dual flash on a bracket. By controlling

the distance and flash head position, you can easily capture many more details.

Accessories for dental photography help to get better pictures.

They include retractors, mirrors, and contrasters. Because they come in contact with the patient's oral cavity, they all should be autoclavable.

Retractors are used to lift the lips away and give better access to the oral cavity. They can be made of plastic or metal.

Two main types exist: self-retracting retractors and single sided retractors. They come in different shapes and sizes.

Self-retracting retractors are used mostly for frontal views and also for occlusal shots.

Single sided retractors are mostly used for lateral views. Plastic retractors are more comfortable for the patients.

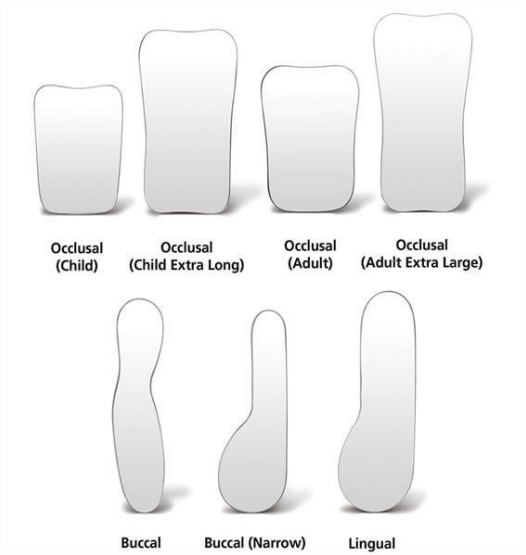
Self-retracting retractor

Single sided retractor

Mirrors are used to capture the reflection of the teeth. They can be made from different materials and with different techniques. The most common mirrors are made of polished metal or glass coated with a highly reflective surface. Depending on the surface coating type, a different reflection percentage will result. A chromium coating reflects 65% of the light, rhodium 75%, titanium 75%, and dielectric coatings such as Ultrabright reflect 99%.

All reflective surfaces will scratch over the time; because of this, mirrors should be replaced from time to time. The coating material does not influence the final picture unless it is scratched or distorted. A less reflective surface needs more energy from the flash to get a proper exposure. Chromium coated mirrors are most common and are cheaper than the others.

Mirrors come in different shapes and sizes, however in daily practice, two shapes are used most often: occlusal and lateral.



Contrasters allow photos of the teeth to be taken with a black background. They come in different shapes and sizes. They are made from black anodized aluminum or from metal plates covered with soft black silicone. Three types are available: anterior, occlusal, and lateral. Recommendation Select contrasters coated with black silicone. It's more durable, will not scratch, and is more pleasant for the patient. The anterior contraster is used most often.

Basic recommended images

Image	Cheek Retractors	Mirror	Technique	Image
Full Face (smiling)	No	No		
Smile	No	No		
Anterior	Yes	No		
Right Buccal	Yes	Yes		
Left Buccal	Yes	Yes		
Maxillary Occlusal	Yes	Yes		
Mandibular Occlusal	Yes	Yes		

Frontal views

Equipment:

• DSLR Camera set with 100mm macro lens and ring flash or dual flash.

Accessories:

• Self-retracting retractor.

• Anterior contraster.

Advice:

• Hold the camera with the back of the camera parallel to the plane of the front teeth.

• Focus on the front teeth.

Shots:

• Retracted view in the MIP position: upper and lower teeth are in the full contact. Upper and lower teeth are visible at least from first molar to first molar.

• Retracted view with teeth apart.

• Upper teeth from canine to canine (with and without contraster).

• Lower teeth from canine to canine (with and without contraster).

Occlusal views

Equipment:

• DSLR Camera set with 100mm macro lens and ring flash or dual flash.

Accessories:

• Self-retracting retractor.

• Occlusal mirror.

Advice:

• 45 degree angle between the mirror and the camera for occlusal shot is recommended.

• Focus on the occlusal surface of the first bicuspids (premolars).

• Full arch should be visible from the central incisors to the mesial of the second molars.

• Eliminate the fog on the mirror (air blow or heat the mirror).

Shots:

• Full upper arch.

• Full lower arch.

Lateral views

Equipment:

• DSLR Camera set with 100mm macro lens and ring flash or dual flash

Accessories:

• Single sided retractor.

• Buccal mirror.

Advice:

• Upper and lower teeth should be visible from the central incisors to the mesial of the second molars.

• Focus on the canine (cuspid).

• Eliminate the fog on the mirror (air blow or heat the mirror).

Shots:

• Right lateral retracted view in the MIP position: upper and lower teeth are in full contact.

• Right lateral retracted view with teeth apart: upper and lower teeth are not in contact.

• Left lateral retracted view in the MIP position: upper and lower teeth are in full contact.

• Left lateral retracted view with teeth apart: upper and lower teeth are not in contact.

Portraits

In portrait photography, the main goal is to capture the full face from the top of the head to the neck in 3 basic positions: lips together, mouth open, and full smile. These types of pictures are used to analyze the esthetics and symmetry of the face.

Camera and flash settings

Mode: Aperture Priority,

Mode: A (Nikon),

Av (Canon) or Manual (M),

Aperture f11,

Shutter Speed: will be set automatically by the camera in A/Av Mode. In Manual Mode, set the speed to 1/200s,

Flash setting: TTL mode,

Auto Focus mode.

Upper & lower teeth
MIP position / retracted view
f>22, 1/200s

Maxillary anterior teeth
retracted view
f>22, 1/200s

Maxillary anterior teeth
retracted view with contraster
f>22, 1/200s

Upper & lower teeth
mouth open / retracted view
f>22, 1/200s

Mandibular anterior teeth
retracted view
f>22, 1/200s

Mandibular anterior teeth
retracted view with contraster
f>22, 1/200s

Maxillary arch / occlusal view
retracted view with mirror
f>22, 1/200s

Right lateral MIP view
retracted view with mirror
f>22, 1/200s

Left lateral MIP view
retracted view with mirror
f>22, 1/200s

Mandibular arch / occlusal view
retracted view with mirror
f>22, 1/200s

Right lateral open view
retracted view with mirror
f>22, 1/200s

Left lateral open view
retracted view with mirror
f>22, 1/200s

CONCLUSIONS

Complementing the training at the dental faculty by analyzing and studying the information array of this textbook, each student will be able to achieve the goal of studying the discipline "Fundamentals of aesthetic dental restoration ", namely to be ready to work in a dental clinic, to determine the belonging of teeth to a particular group, side, maxilla or mandible, taking into account their clinical and anatomical features, signs; know use of instruments to determine the presence of a carious cavity; determine carious cavities of I-VI classes according to Black, use dental instruments, according to the purpose; to fill carious cavities of Black's classes I - VI with materials of different groups, modeling the shape of teeth using various techniques when performing aesthetic restorations.

The textbook contains information that will help to determine of nature and principles of treatment in the therapeutic dentistry clinic when planning aesthetic restoration.

LIST OF TEST TASKS AND QUESTIONS FOR SELF-CONTROL

1. The tooth has a massive conical crown, the cutting edge forms a pronounced tooth.
A. Upper canine
B. Lower first premolar
C. Upper second premolar
D. Upper second incisor
E. Lower second premolar
2. The tooth cavity has a conical shape, gradually transforming into a wide rounded root canal. Which teeth have a cavity of this shape?
A. Lower incisors
B. Lower premolars
C. Upper premolars
D. Upper first premolars
E. Upper canines
3. The shape of the tooth cavity is elongated in the buccal-palatal direction and passes into two rather narrow canals. Which tooth has a cavity of this shape?
A. First upper premolar
B. Lower premolar
C. Upper canine
D. Upper second incisor
E. Lower second premolar
4. In the group of premolars of the upper and lower jaws, root bifurcation in different parts of its length is most often observed in:
A. Lower first premolar
B. Lower second premolar
C. Upper first premolar
D. Upper second premolar
5. In the premolar group, two canals are most often (85% of cases) found in:
A. Lower first premolar
B. Lower second premolar
C. Upper second premolar
D. Upper first premolar

6. What is the number of roots and root canals in the lower first and second premolar?
A. One root and one canal
B. One root two canals
C. Two roots one canal
D. Two roots two canals
7. What is the number of roots and root canals in the upper second premolar?
A. One root two canals
B. Two roots one canal
C. Two roots two canals
D. One root one canal
8. The essence of the root sign for a molar is that the tops of the roots of the chewing group of teeth are deviated from the midline:
A. Distally
B. Medially
C. Buccally
D. Palatally
9. For teeth of the masticatory group, the crown angle sign means that sharper angles are formed by the surfaces
A. Chewing and medial
B. Chewing and buccal surfaces
C. Masticatory and lingual
D. Masticatory and distal
E. Distal and buccal
10. For molars, the sign of crown curvature means that the most convex part of the vestibular surface of the tooth crown is the
A. Distal surface
B. Medial surface
C. Gradually passes into the distal and medial surface
D. Chewing surface
11. When restoring crown 36, the dentist used the surface feature. For molars, the surface feature means that the medial surface of the crown compared to the distal (lateral) surface:
A. is always lower
B. more convex

C. always wider
D. always narrower
E. always higher
12. Which teeth have three roots?
A. Incisors, canines, lower premolars and upper first premolars
B. Incisors, canines and lower premolars
C. Incisors, canines, upper and lower premolars
D. Upper molars
E. First upper premolars
13. Crowns of which teeth have an additional tubercle?
A. First molars of the lower jaw
B. Second molars of the lower jaw
C. First molars of the upper jaw
D. Premolars
E. Second molars of the upper jaw
14. The shape of the tooth crown is close to a cube, somewhat elongated along the dentition and slightly flattened vertically. There are five tubercles on the chewing surface. Name the tooth:
A. lower first premolar
B. lower first molar
C. upper first molar
D. upper second molar
E. lower second molar
14. The shape of the crown of the tooth is close to a cube, somewhat elongated along the dentition and slightly flattened vertically. There are five tubercles on the chewing surface. Name the tooth:
A. lower first premolar
B. lower first molar
C. upper first molar
D. upper second molar
E. lower second molar
15. The tooth has a rhomboid crown elongated in the mediodistal direction. On the chewing surface there are four tubercles: two buccal and two palatal, separated by an H-shaped sulcus. There is an additional tubercle (Carabelli) on the anteropalatine tubercle on the side of the oral surface. Name the tooth:

A. lower first molar
B. lower first premolar
C. upper first molar
D. upper second molar
E. lower second molar

16. According to Black's classification of carious cavities, cavities located in the area of fissures and natural grooves of all tooth groups are classified as:
A. I class
B. Class II
C. Class III
D. Class IV
E. V class

17. According to Black's classification of carious cavities, cavities located on the contact surfaces of the upper incisors and canines with preservation of the cutting edge belong to:
A. Class V
B Class II
C. Class III
D. I class
E. Class IV

18. According to Black's classification of carious cavities, cavities located on the contact surfaces of the upper incisors and canines with violation of the angles and cutting edge of the crown are classified as:
A. Class IV
B. Class II
C. Class V
D. Class III
E. Class I

19. According to Black's classification of carious cavities, cavities located on the contact surfaces of upper molars and premolars belong to:
A. III class
B. Class I
C. Class II
D. Class IV

E. Class V
20. According to the classification of carious cavities, the cavities located on the cutting edge of the anterior and lateral teeth are:
A. Class II
B. Class V
C. Class III
D. Class I
E. Atypical cavities
21. According to Black's classification of carious cavities, cavities on the labial, buccal and lingual surfaces located in the gingival part of the tooth crown belong to:
A. IV class
B. Class I
C. Class II
D. Class V
E. Class III
22. What instruments are used for grinding and polishing the surface of the filling?
A. Spherical burs, fissure burs
B. Fissure burs, reverse cone burs
C. Finishes, polishes
D. Wheel-shaped burs, carborundum heads
23. Preparation of a carious cavity includes:
A. Anesthesia, necrectomy, finishing, expansion of the carious cavity
B. Expansion of the carious cavity, necrectomy, finishing, drug treatment
C. Opening of a carious cavity, necrectomy, formation of a carious cavity, finishing of the enamel edges
D. Expansion of the carious cavity, necrectomy, medical treatment
E. Anesthesia, necrectomy, finishing
24. Elements of the prepared carious cavity:
A. Bottom, wall, corner, edge
B. Dentin bridge, concave bottom, enamel fold
C. Enamel edge, additional cavity, notches
D. Fold, additional cavity, tunnel
E. Necrotic dentin, enamel prisms, grooves

25. The criterion for the final preparation of a carious cavity is
A. The presence of soft and pigmented dentin on the bottom and walls of the carious cavity
B. The presence of light and dense dentin on the bottom and walls of the carious cavity, stained with a caries detector
C. The presence of light and dense dentin on the bottom and walls of the carious cavity without staining with a caries detector
D. The presence of dense pigmented dentin at the bottom of the carious cavity
E. Opening of the tooth cavity
26. Classification of carious cavities by Black includes:
A. 6 classes
B. 5 classes
C. 8 classes
D. 3 classes
E. 7 classes
27. Prepared carious cavity of class V has the following shape:
A. box-shaped
B. rhomboid
C. cruciform
D. horseshoe-shaped
28. For a class I carious cavity, the most typical shape is:
A. round
B. square
C. box-shaped
D. horseshoe-shaped
29. When preparing a deep carious cavity in a molar on the chewing surface, the bottom of the cavity is formed:
A. flat
B. concave
C. convex
D. arbitrary shape
30. Retention points in the formation of the cavity are created for:
A. better fixation of the filling
B. prevention of secondary caries development
C. removal of necrotic tissue

D. better cosmetic properties of the filling
31. How should a class V carious cavity be formed?
A. box-shaped with steep walls
B. form an inlet smaller than the bottom
C. to form an inlet wider than the bottom
D. make it spherical
E. make a cavity with a step
32. There is a deep class I carious cavity on the chewing surface 36. What kind of bur should be used to form the bottom of the carious cavity?
A. Wheel-shaped boron of small size
B. Large spherical bur
C. Small fissure bur
D. A large fissure bur
E. A small spherical bur
33. Enamel and dentin etching is performed for:
A. Strengthening the bactericidal properties of composites
B. Improving the quality of the edge fit, to remove the lubricated layer
C. Medical treatment of carious cavities
D. Creating a hybrid layer
E. Enamel remineralization
34. The connection of enamel adhesives with tooth enamel occurs due to:
A. Penetration of the bonding agent into the micropores of the enamel
B. Formation of a chemical bond
C. Formation of a hybrid layer
D. Formation of a lubricated layer
E. Adhesive expansion during polymerization
35. The primer provides:
A. Removal of the lubricated layer
B. Preparation of hydrophilic dentin for bonding to the composite
C. Moisturizing the dentin
D. Enamel preparation for adhesive application
E. Reducing sensitivity after filling
36. What inorganic acid is used to etch enamel before filling with a composite material?

A. 5-10% oxalic
B. 1-2% citric acid
C. 30-40% orthophosphoric
D. 0.3-1% maleic
E. 10-15% formic
37. Adhesive systems include:
A. Aluminum silicate
B. Dentin paste
C. Bonding agent
D. Acetone
E. Alcohol
38. After application of a one-component adhesive system, the dentin surface should be:
A. Overdried
B. Slightly moist
C. Abundantly moistened
D. Matte
E. Bright white in color
39. Which of the following is part of the lubricated layer:
A. Components of the oral fluid
B. Microorganisms
C. Fragments of collagen fibers
D. Fragments of hydroxyapatite crystals
E. All of the above
40. Modern view on the issue of enamel and dentin etching time before composite filling:
A. Enamel - 15-30 seconds, dentin - up to 15 seconds.
B. Enamel - 30-60 seconds, dentin - up to 30 seconds.
C. Enamel - 1.5 minutes, dentin - up to 15 seconds.
D. Enamel - 15-30 seconds, dentin - 40 seconds.
E. Enamel - 40-60 seconds, dentin - up to 40 seconds.
41. How many "generations" do adhesive systems have?
A. 5
B. 7
C. 6
D. 4

E. 8
42. A "primer" provides:
A. Preparation of dentin for bonding to the composite
B. Preparation of the enamel for bonding to the composite
C. Preparation of the enamel for bonding to the adhesive
D. Preparation of the enamel for conditioning
E. Preparation of dentin for conditioning
43. Adhesives of which generation are characterized by hydrophobicity?
A. I and V
B. II and III
C. III and IV
D. V and VII
E. I, II, III
44. The method of total etching involves:
A. Etching only the enamel
B. Etching only dentin
C. Complete absence of etching
D. Etching of enamel and dentin
E. Etching of the enamel-dentin border
45. All adhesives can be divided into:
A. Dentin, dentin-cement, universal
B. Enamel, universal
C. Enamel, dentin, cement
D. Enamel, dentin, universal
E. Enamel, dentin-cement, cement
46. What are the requirements for adhesive systems?
A. Provide good initial and long-term bonding strength of the material to the tooth tissue
B. Provide low thermal conductivity
C. The coefficient of thermal expansion should be close to the hard tissues of the tooth
D. Accelerate the processes of regenerative dentinogenesis
E. Easy to insert into and remove from the cavity
47. Criteria for the quality of hard tooth tissue etching:

A. After drying, the enamel surface remains unchanged; dentin is chalky
B. After drying, the enamel surface remains moist; the dentin is shiny
C. After drying, the surface of the enamel becomes chalky; the dentin is not changed
D. Enamel and dentin cannot be dried
E. After drying, the surface of the enamel becomes chalky; the dentin is shiny
48. Self-etching adhesive systems (VI generation) include the following systems:
A. Those that do not involve etching of tooth tissues
B. Those that etch the tooth tissue without washing off the etching gel
C. Those that etch the tooth tissue with subsequent rinsing of the etching gel
49. What is the name of the layer formed on the surface of dentin as a result of preparation?
A. Hybrid
B. Lubricated
C. Dispersed
D. Inhibited
50. State the main component of a primer:
A. Filler
B. Hydrophilic monomer
C. Stabilizer
D. Organic acid
E. All of the above
51. Select the filling material that is appropriate for filling a Black class IV carious cavity in 21 teeth:
A. composite
B. Light-curing glass ionomer cement
C. Microhybrid composite
D. Macro-filled composite
E. Mini-filled composite
52. What accessories should be used when filling a carious cavity of Black's class II with a light-curing composite to create a contact point?
A. Metal matrix and matrix holder

B. Transparent matrix and wedges made of transparent material
C. Transparent die and wooden wedges
D. Metal matrix and wooden wedges
E. Celluloid cap and transparent wedges
53. How to correctly introduce a light-curing composite filling material into a carious cavity during its filling:
A. In small portions, rubbing against the walls
B. In small portions
C. In layers, with oblique layers
D. In 1-2 portions
E. In one single portion
54. Name the main disadvantages of photopolymer composite filling materials:
A. High polymerization shrinkage
B. High thermal conductivity
C. Low polymerization shrinkage
D. Significant solubility in water
E. High level of abrasion
55. The luminous flux of polymerization lamps contains a significant proportion of radiation:
A. Infrared
B. Magnetic
C. Laser
D. Ultraviolet

CONTROL QUESTIONS

1. Fundamentals of restorative dentistry, its relationship with other dental disciplines. The concept of minimally invasive dentistry.
2. Prediction and planning of the aesthetic result of restorations.
3. Anatomical and morphological features shape of the upper and lower jaws' teeth and their importance for the successful outcome of aesthetic restoration.
4. Tools for restorations.
5. Cofferdam in dentistry. Principles of isolation of the working field.
6. Methods of applying cofferdam during the restoration of different groups of teeth. Selection of clasps.
7. Methods of retraction.
8. Modern materials for aesthetic dental restoration. Auxiliary materials.
9. Selection of composite material and its shades during dental restoration.
10. The concept of polychrome restoration.
11. Principles of preparation of various cavities according to Black to ensure the aesthetic result of artistic restoration.
12. Methods of processing the prepared cavity.
13. Fundamentals of adhesion in aesthetic dentistry. Principles of adhesive bonding.
14. Generations of bonds. Methods of adhesive treatment of the tooth surface.
15. Principles of working with composite materials. Features of material introduction.
16. Methods of stratification. Approaches to the adaptation of composite material.
17. Restoration of cavities I-II classes according to Black.
18. Adaptation of matrices and restoration of the contact point in the technique of direct restoration.
19. Restoration of cavities III-IV Black classes.
20. Silicone key (template) technique.
21. Principles of modeling shape the teeth by various techniques in the implementation of aesthetic restorations.
22. Carving, finishing, and polishing of composite restorations.

23. Restoration of the crown part of a tooth after endodontic treatment. Features of layered restoration.
24. Composite restorations on pins. Types of pins. Indications for use.
25. Methods of placing pins. Restoration of the crown part of the tooth with the help of pins.
26. Approaches to the correction and replacement of defective composite restorations: choice of method, advantages, and disadvantages of the applied approaches.
27. The application of fiberglass tape in practice composite restoration of areas missing teeth.
28. Synergy of function and aesthetics to achieve a successful result of aesthetic dental restorations.
29. Biomechanics of functioning of the composite restorations. The concept of critical zones.
30. Success rates and main reasons for the failure of composite aesthetic restorations in the short and long term.
31. Teeth whitening as a method of discoloration correction. Approaches, active agents, indications and contraindications, advantages and disadvantages.
32. Protocols for photo documentation during aesthetic restoration. Basic camera settings for recording the initial state of dental status.
33. Mirrors, retractors, and contrasters for high-quality photography. Features of macrophotography in dentistry.

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Main literature

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3. Stomatology: textbook: in 2 books. Book 2 / M.M. Rozhko, 1.I. Kyrylenko, O. H. Denysenko et al.; edited by M. M. Rozhko. – Kyiv: AUS Medicine Publishing, 2018. – 960 p.; color edition.

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3. Dental Composite Materials for Direct Restorations Softcover reprint of the original 1st ed. by Vesna Miletic. Publisher: Springer; 1st edition , 2018 .– 327p.
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2. Online resource - https://www.academia.edu/44473961/Dental_Composite_Materials_for_Direct_Restorations
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