PRINCIPLES OF TOOTH PREPARATION

Learning objective

- By the end of this session student will know the defination, objectives and principles of tooth preparation.

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INTRODUCTION

Tooth preparation may be defined as the mechanical treatment of dental disease or injury to hard tissue that restores a tooth to the original form (Tylman).

The current focus is on conservative tooth preparation that is noninvasive and that minimally involves dentin. This trend is rational in the light of the reduction of the caries rate by fluorides, nutritional counseling and oral hygiene programs. Black's principles of cavity preparation and Tylman's principles of tooth preparation are both presently being modified to accommodate imaginative approaches i.e., acid etching with minimum reduction. Dentistry is changing from macro tooth preparation to an environment of molecular chemistry i.e., esthetic bonding. These techniques are not presently supported by longitudinal studies, but are exciting and promising.

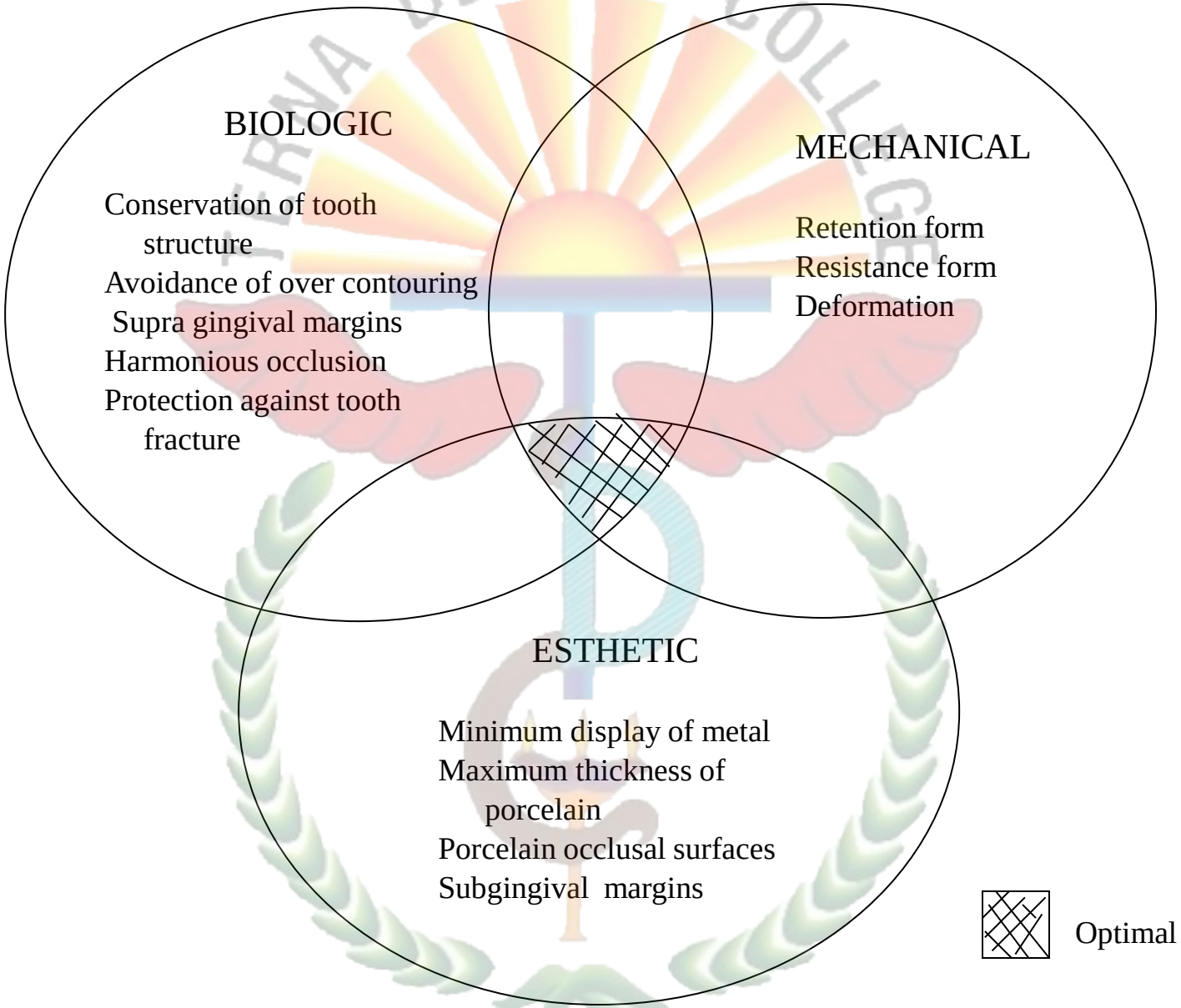
Despite these advances, traditional crowns are still indicated for majority of patients. The classic design of the preparation must be visualized so that modifications if required can be instituted. Diagnosis and disciplined tooth preparation are essential to successful fixed prosthodontics.

OBJECTIVES OF TOOTH PREPARATION

The objectives of preparation remain clearly defined, but the methods of securing these goals are constantly being revised.

1. Reduction of the tooth in miniature to provide retention.
2. Preservation of healthy tooth structure to secure resistance form.
3. Provision for acceptable finish line.
4. Performing pragmatic axial tooth reduction to encourage favorable tissue responses from artificial crown contour i.e., fluting of molars.

PRINCIPLES OF TOOTH PREPARATION
(According to Rosenstiel)



PRINCIPLES OF TOOTH PREPARATION

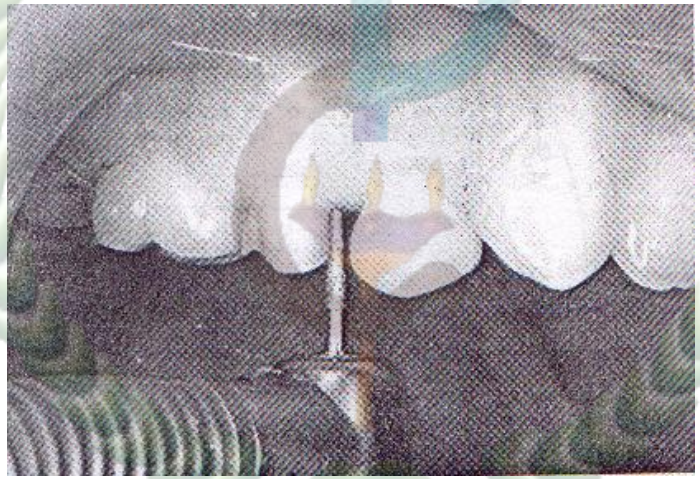
According to Shillingburg, the design of a preparation for a cast restorations and the execution of that design are governed by five principles:

1. Preservation of tooth structure
2. Retention and resistance
3. Structural durability
4. Marginal integrity
5. Preservation of the periodontium.

BIOLOGIC CONSIDERATIONS

Prevention of damage during tooth preparation :

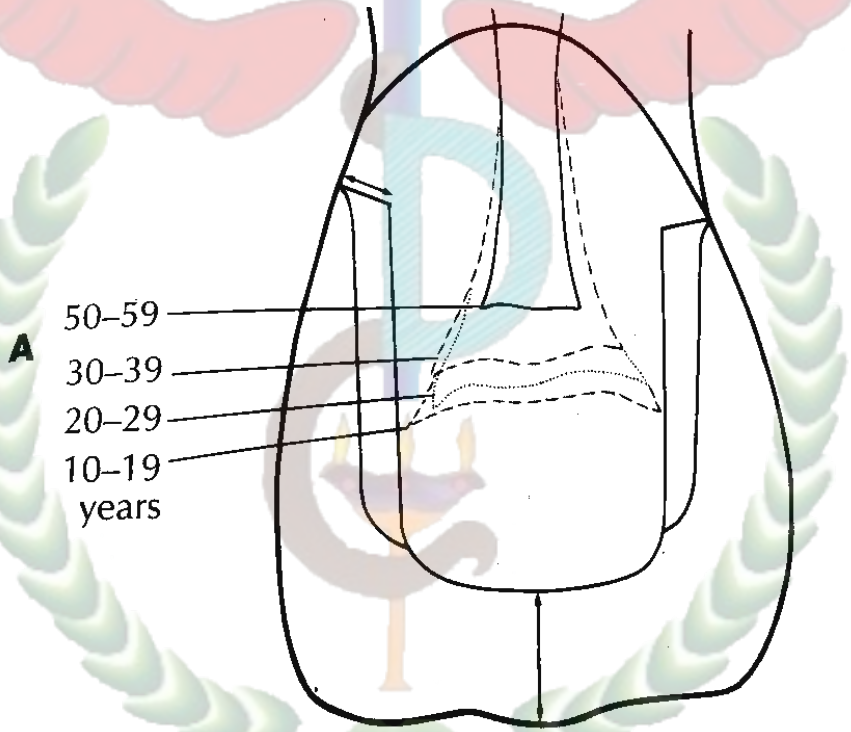
Adjacent tooth: Iatrogenic damage to an adjacent tooth is a common error during tooth preparation. Even if a damaged proximal contact area is carefully reshaped and polished, it will be more susceptible to dental caries than the original undamaged tooth surface. This is presumably because undamaged surface enamel contains higher fluoride concentrations and the interrupted layer is more prone to plaque retention. The techniques of tooth preparation must avoid and prevent damage to the adjacent tooth surfaces.



It may help to use a metal matrix band around the adjacent tooth as protection. The preferred method is to use the proximal enamel of the tooth being prepared for protection of the adjacent structure. Teeth are 1.5 to 2 mm wider at the contact area than at the cementoenamel junction and a thin tapered diamond can be passed through the interproximal contact area to leave a slight lip or fin of enamel without causing excessive tooth reduction or undesirable angulation of the rotary instrument.

Soft tissues : Damage to the soft tissues of the tongue and cheeks can be prevented by careful retraction with an aspirator tip, mouth mirror, or flanged saliva ejector. Great care is needed to protect the tongue when the lingual surface of the mandibular molars is being prepared.

Pulp : Great care is also needed to prevent Pulpal injuries during tooth preparation and restoration. Extreme thermal or chemical irritation or microorganisms can cause an irreversible pulpitis, particularly when they occur on freshly sectioned dentinal tubules. Prevention of Pulpal damage necessitates selection of techniques and materials that will reduce the risk of damage while preparing tooth structure.

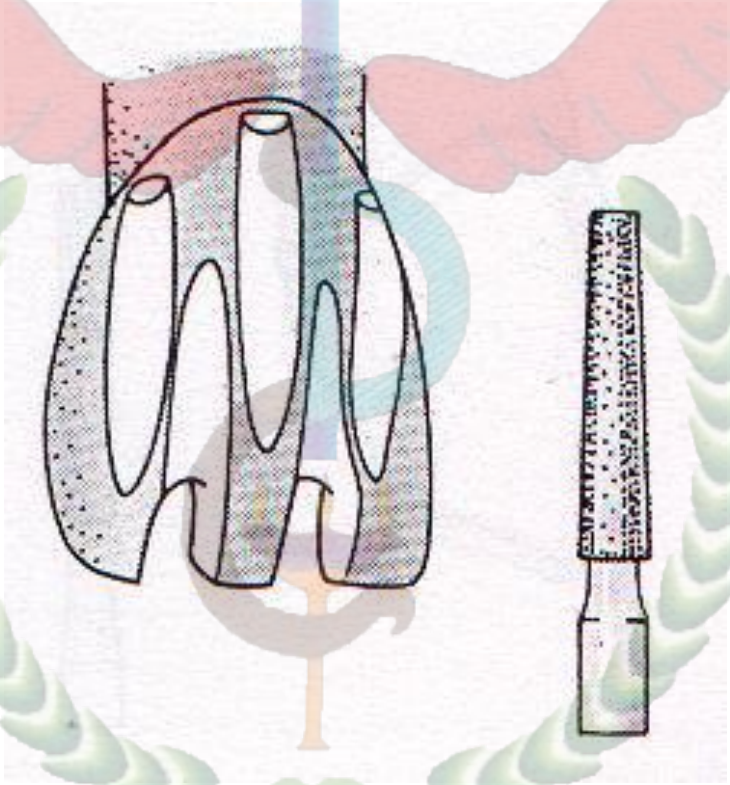


Langeland (1965) Made a study on effects of the tooth preparation on pulp changes. He summarized that,

- Crown preparation requires water coolant strong enough to penetrate between the rotary instrument and tooth.
- Impression materials may cause heat or chemical injury to the pulp.
- Preformed temporary crowns should be cemented with thick mix of zinc oxide eugenol.
- In final cementation of crown restorations, the prepared tooth should not be excessively dried nor bactericidal applied to dentin.

Loforgia (1991) reported pulpal injury following heat rise in vivo, 5.5^0 rise led to necrosis – 15% of pulp; 11.2^0 – 60% ; 16.6^0 - 100% damage to pulp. He concluded that, stable handpiece, sharp diamond stones and minimal reduction of dentin using air – water spray coolant resulted in minimal damage to the pulp.

Depth of reduction : Proper control is best provided by placing strategically located depth cuts in the unprepared tooth surfaces. These cuts are placed to the desired depth, and then intervening tooth structure is removed using of the depth cut as a guide to proper reduction.



Thermal injury : Thermal injury to the pulp may be prevented by adoption of the following measures.

Speed of reduction : Rapid continuous removal of tooth structure causes rapid heat build up with a greater potential for irreversible pulpitis. Reduction should be performed intermittently in a steady controlled manner. Reducing the tooth for a period of 5 to 10 seconds and then removing the instrument from the surface for a few second is helpful in avoiding excess heat build up.

Instrument age and use of pressure : Only sharp instruments should be used for bulk tooth reduction, since dull ones create more friction and thus more heat. A worn diamond instrument or partially dull bur may be advantageous to smooth a preparation but should not be used to remove significant amounts of tooth structure.

Rotary instruments must be held firmly against the tooth to permit controlled removal of tooth structure. However, use of excess pressure or rapid reduction should be avoided, since this causes undue heat generation. This problem is accentuated if dull instruments are used.

Use of coolants: Application of a coolant to the surface of a material as it is long been used to reduce heat build up and this procedure is not beneficial during tooth preparation.

Hand pieces can deliver a water stream, water spray, or air to the rotary instrument on to the tooth surface during reduction. A water stream is the most effective means of cooling, followed by a water spray, and then air. In order to minimize Pulpal trauma and postoperative discomfort, a water stream or spray should always be used during bulk tooth removal.

Chemical injury: The chemical action of certain dental materials like, bases, restorative resins, solvents and luting agents can cause Pulpal damage, particularly when applied to freshly cut dentin. Cavity varnish will form an effective barrier in most instances and appears to have little effect on the retention of a cemented restoration.

Bacterial injury: Pulpal damage under restorations has been attributed to the action of bacteria that either were left behind or gained access to the dentin because of micro leakage. However, many dental materials, including zinc phosphate cement have an antibacterial effect, and vital dentin seems to resist infection, the routine use of antimicrobial agents is unnecessary.

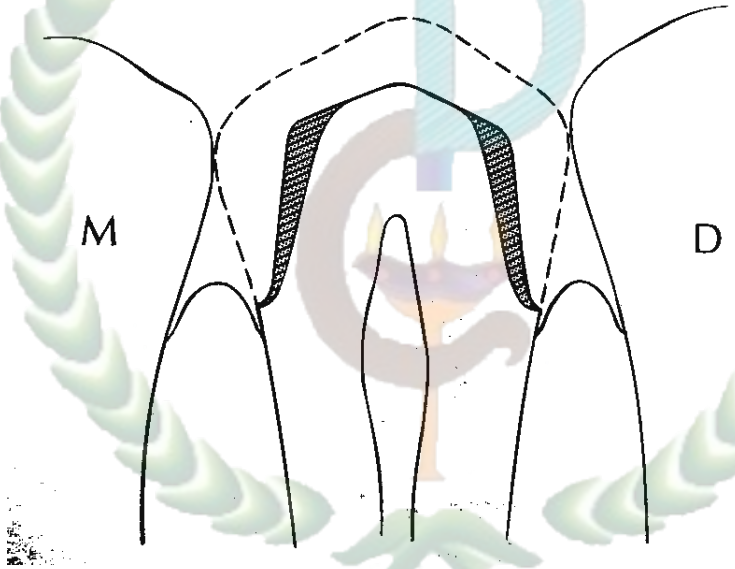
However, it is important to removal all carious dentin before placing a restoration that will serve a foundation for a fixed prosthesis. An indirect pulp cap is not recommended, as its later failure is likely to jeopardize extensive prosthodontic treatment.

CONSERVATION OF TOOTH STRUCTURE

One of the basic tenets of restorative dentistry is to conserve as much tooth structure as possible consistent with the mechanical and esthetic principles of tooth preparation.

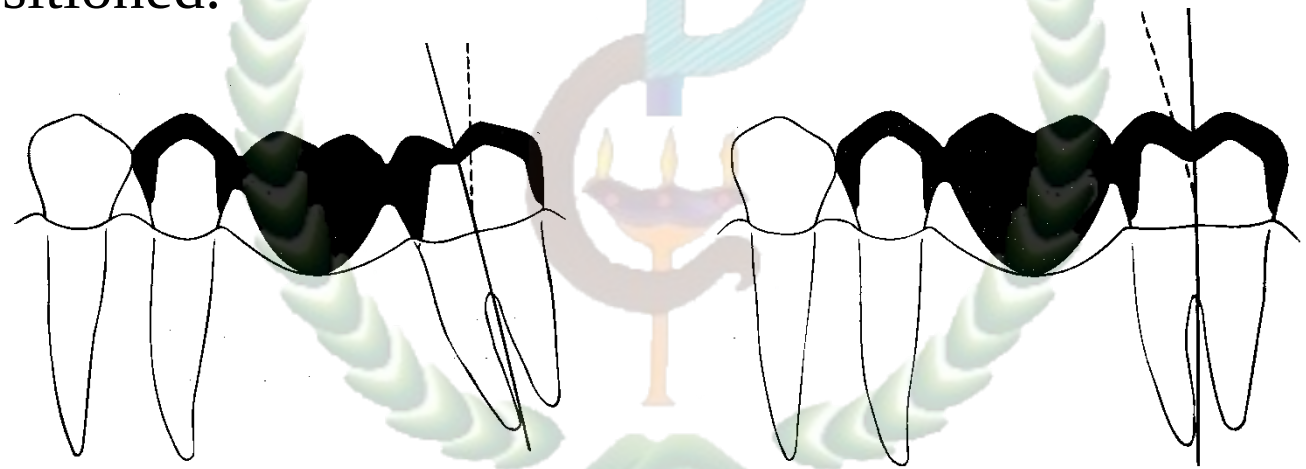
Tooth structure is conserved by employing the following guidelines:

1. Use of partial coverage rather than full coverage restorations.
2. Preparation of teeth with minimum taper between axial walls.

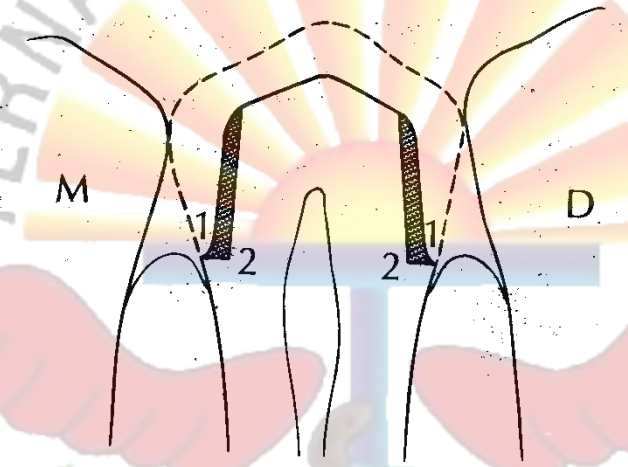


3. Occlusal reduction following anatomic planes to give uniform thickness in the restoration.

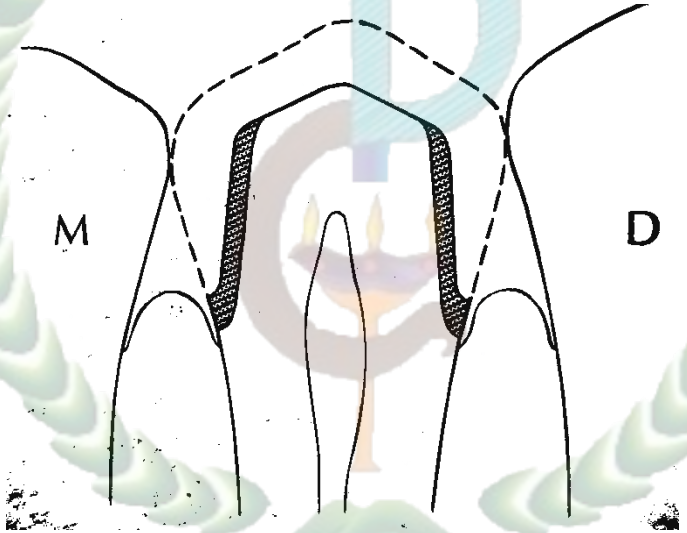
4. Preparation of the axial surfaces so that the tooth structure is removed evenly; if necessary, teeth should be orthodontically repositioned.



5. Selection of a conservative margin compatible with the other principles of tooth preparation.



6. Avoiding of unnecessary apical extension of the preparation.



CONSIDERATIONS AFFECTING FUTURE DENTAL HEALTH

Axial reduction: Gingival inflammation is commonly associated with crowns and FPD abutments having excessive axial contours, as it is more difficult for the patient to maintain plaque control around the gingival margins. It is essential that a tooth preparation provide sufficient space for the development of good axial contours. This will enable the junction between the restoration and the tooth to be smooth and free of any ledges or abrupt changes in direction.

Unless a restoration is needed to correct a malformed or malpositioned tooth, a crown should duplicate the contours and profile of the original tooth. Sufficient tooth structure must be removed to allow the development of correctly formed axial contours, particularly in the interproximal and furcation areas, where periodontal disease often begins.

Margin placement: Whenever possible, the margin of the preparation should be supragingival. Subgingival margins of cemented restorations have been identified as a major factor in periodontal disease, particularly when they encroach on the epithelial attachment. Supragingival margins are easier to prepare accurately without trauma to the soft tissues. They are usually located on enamel, whereas subgingival margins are either on dentin or on cementum.

Advantages of supragingival margins :

1. They can be easily finished.
2. They are more easily kept clean.
3. Impressions are more easily made, with less potential for soft tissue damage.
4. Restoration can easily be evaluated at recall appointments.

Indication of subgingival margins :

1. Dental caries, cervical erosion, or restorations extending subgingivally and where crown lengthening procedures are not indicated.
2. Proximal contact area extending to the gingival crest.
3. Need for additional retention.
4. Masking of margin of a metal ceramic restoration behind the labiogingival crest.
5. Root sensitivity that cannot be controlled by more conservative procedures.
6. Modification of the axial contour is indicated.

New Comb (1974) made study on subgingival crown margin.

As the subgingival crown margin approaches the base of the gingival crevice, the more likely the inflammation occurs. The least inflammation occurs when the subgingval margins are placed at the gingival crest or just into the gingival crevice.

Block (1987) made study on indiscriminate placement of margins of restoration into gingival crevice. He concluded that,

- Placing the margin into gingival crevice for the purpose of esthetics or protection from decay can no longer be considered a good practice.
- Minimum 3 mm attached gingiva should be present before subgingival placement.

Margin adaptation:

- 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 less will be the chance of recurrent caries or periodontal disease.
- A well-designed preparation should have a margin that is smooth and even.
- Rough, irregular or stepped junctions greatly increase the length of the margin and substantially reduce the adaptation of the restoration.
- Time spent obtaining a smooth margin will make the subsequent steps of tissue displacement, impression making, die formation, waxing and finishing much easier, and ultimately provide the patient with a longer lasting restoration.

Margin geometry :

The following guidelines for margin design should be considered:

1. Ease of preparation without overextension.
2. Readily identifiable in the impression and on the die.
3. A distinct boundary to which the wax pattern can be finished.
4. Sufficient bulk of material is provided.
5. Conservation of tooth structure (provided other criteria are met).

William G Reeves (1991) made study on margin placement for optimum periodontal health. If restoration margins placed subgingivally,

a) Emergence profile → food deflection theory advocating overbulking of the gingival third of restoration acts as a defective contour to protect gingival tissue from injury.

b) Improperly finished margins → in may cases overhanging or large open margins are probably left because of inadequate impression or improper preparation margin.

Occlusal considerations :

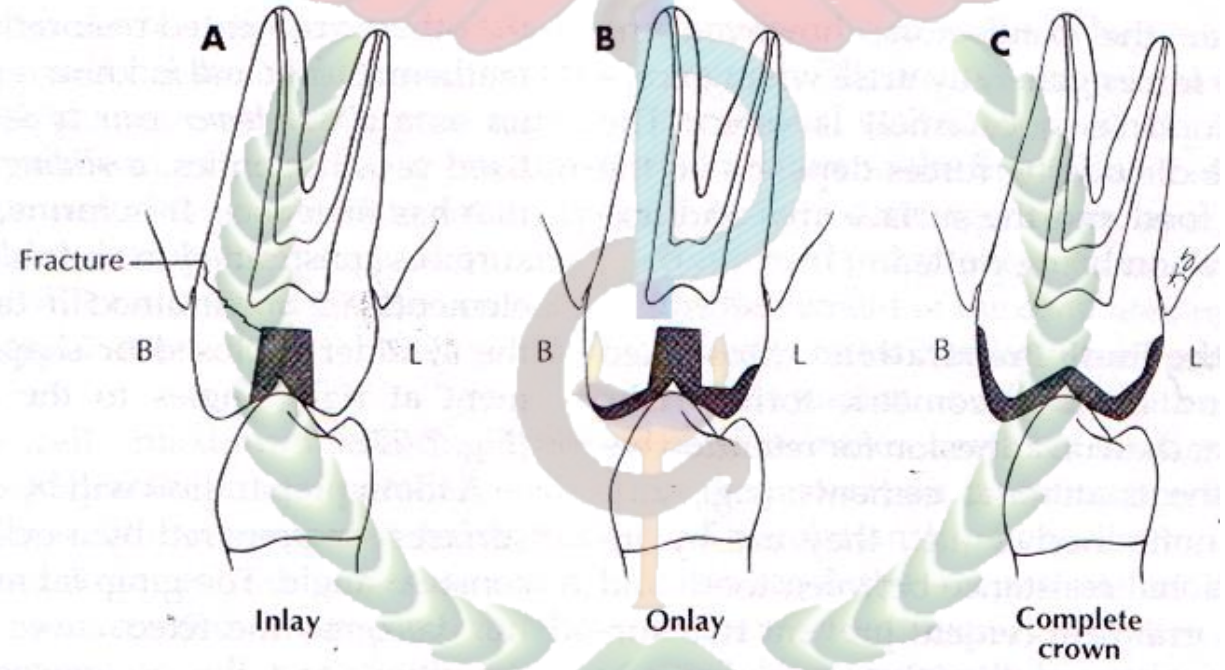
A satisfactory tooth preparation should allow sufficient space for developing a functional occlusal scheme in the finished restoration. Sometimes a patient's occlusion is disrupted by supraerupted or tilted teeth. When these teeth are prepared for restoration, the eventual occlusal plane must be carefully analyzed and the teeth reduced accordingly. Often considerable reduction is needed to compensate for the supraeruption of abutment tooth.

Sometimes even endodontic treatment is necessary to make enough room. Under these circumstances, an apparent violation of the principle of conservation of tooth structure is preferable to potential harm from a traumatic occlusal scheme. In these situations, diagnostic tooth preparations and waxing procedures are essential to determine the exact amount of reduction that will be required to develop an optimum occlusion.

Prevention of tooth fracture :

No tooth is unbreakable. If teeth are smashed together, (as in automobile accidents, sports injury or biting hard object) a cusp may fracture. Cuspal fracture also can occur from parafunctional habits such as bruxism.

The likelihood that a restored tooth will fracture can be lessened if the tooth preparation is designed to minimize potentially destructive stresses.



MECHANICAL CONSIDERATIONS

The design of tooth preparations for fixed prosthodontics must follow certain mechanical principles; otherwise the restoration may become dislodged or may distort or fracture during service. These principles have evolved from theoretical and clinical observations and are supported by experimental studies.

Types of occlusal forces :

Three types of forces can be directed against a prosthesis during function: i) Tipping forces, ii) Twisting or rotational forces and iii) Path of insertion forces.

i) Tipping force can occur in buccolingual or mesiodistal directions, depending on the point and direction of force of application.

ii) Twisting or rotational forces may cause a restoration to start to move circumferentially around the prepared tooth. For example, if a facially directed force is applied to only one retainer, the periodontal ligament permits some facial movement of that abutment tooth, producing rotational movement of the retainers.

iii) Path of insertion forces can be apically or occlusally directed, depending on whether the mandible is closing into a bolus of food or opening with sticky food interposed between the opposing teeth and the prosthesis. The magnitude of dislodging forces depends on the stickiness of the food and the surface area and texture of the restoration being pulled. A fixed partial denture can also be subjected to path of withdrawal forces by pulling with floss under the connectors.

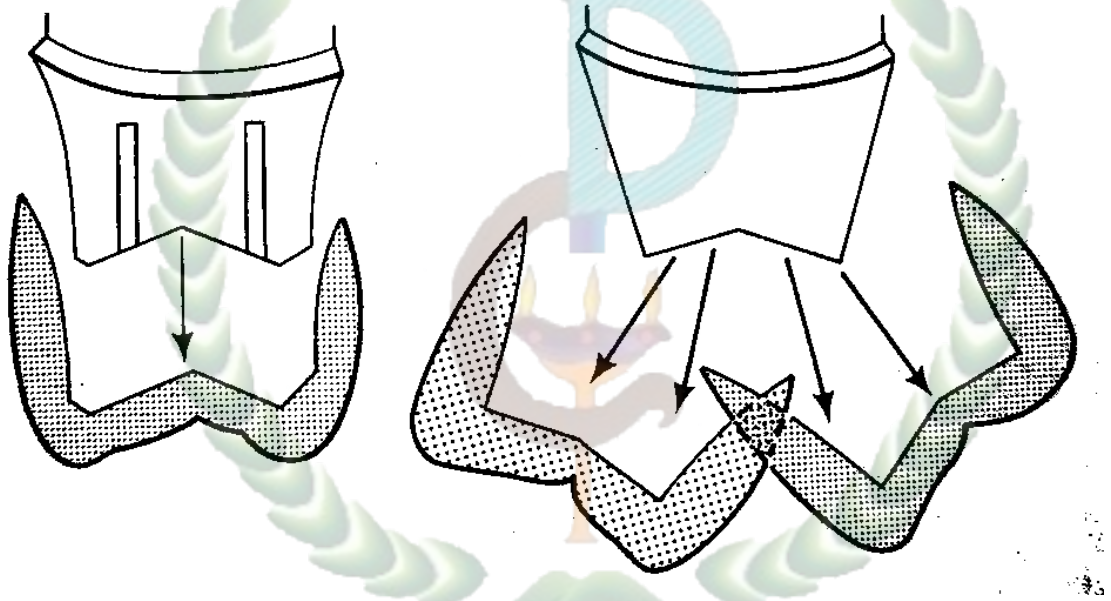
RETENTION FORM

The quality of a preparation that prevents the restoration from being dislodged by forces parallel to the path of withdrawal is known as retention. Thus retention prevents removal of the restoration along the path of insertion or long axis of the tooth preparation. Only dental caries and porcelain failure outrank lack of retention as a cause of failure of crowns and fixed partial dentures.

Fixed prostheses depend on the geometric form of the preparation rather than on adhesion for retention. This is because most be the traditional cements (e.g. zinc phosphate) are nonadhesive i.e., they act by increasing the frictional resistance between the tooth and the restoration. The grains of cement prevent two surfaces from sliding, although they do not prevent one surface from being lifted from another. Again, cement is effective only if the restoration has a single path of withdrawal i.e., the tooth is shaped to restrain the free movement of the restoration.

Path of insertion :

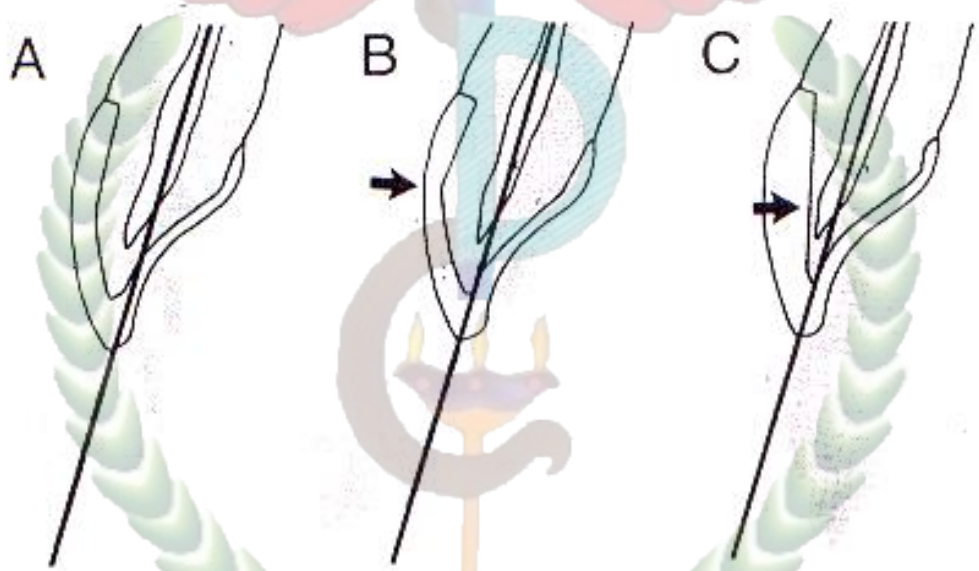
The path of insertion is an imaginary line along which the restoration will be placed onto or removed from the preparation. The path of insertion is to be determined before the preparation is begun and not arbitrarily set at the completion of the preparation. It is of utmost importance when preparing teeth to be fixed partial denture abutments since the paths of all the abutments must be parallel to each other.



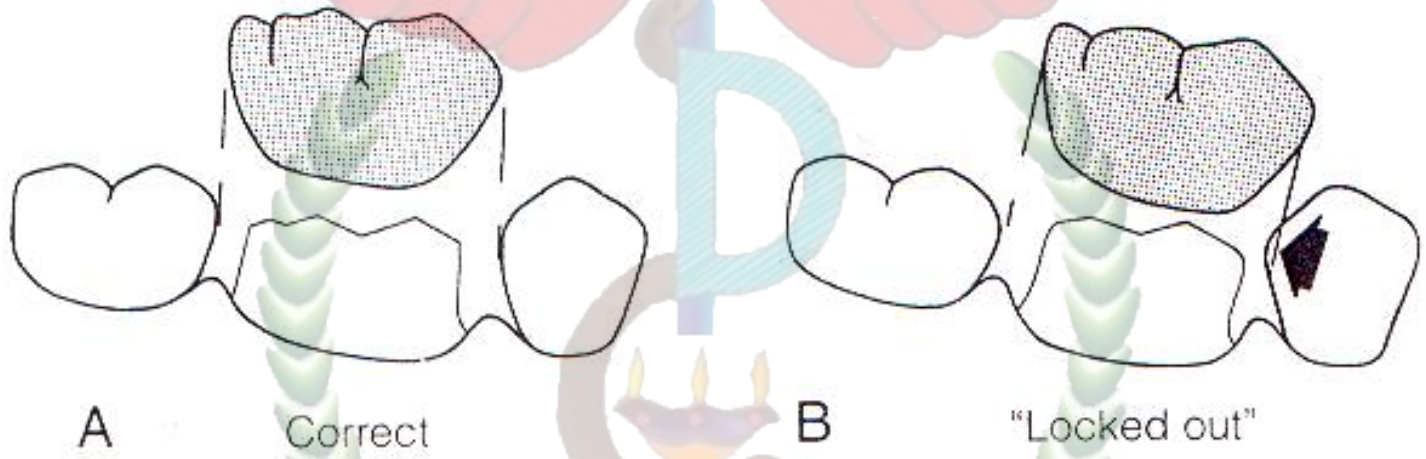
The correct technique must be used to survey a preparation visually, since this is the primary means of ensuring that the preparation is neither undercut nor over tapered. If the centre of the occlusal surface of a preparation is viewed with one eye from a distance of approximately 30 cm (12 inches), it is possible to sight down the axial walls of the preparation with a minimum taper.

For a preparation to be surveyed in the mouth, where direct vision is rarely possible, a mouth mirror is used. It is held at an angle approximately ½ inch above the preparation, and the image is viewed with one eye. If fixed partial denture abutment preparations are being evaluated for a common path of insertion, a firm finger rest is established and the mirror is maneuvered until one preparation is centered. Then pivoting on the finger rest, the mirror is moved, without changing its angulations, until it is centered over the second preparation.

The path of insertion must be considered in two dimensions; faciololingually and mesiodistally. The faciolingual orientation of the path can affect the esthetics of metal ceramic or partial veneer crowns. For metal ceramic crowns, the path is roughly parallel with the long axis of the teeth. A facially inclined path of insertion on a preparation for a metal ceramic crown will leave the facioocclusal angle too prominent, resulting in overcontouring of the restoration.



The mesio-distal inclination of the path must parallel the contact areas of adjacent teeth. If the path is inclined mesially or distally, the restoration will be held up at the proximal contact areas and be “locked out”. This is a particular problem when restoring a tilted tooth. In this situation, making the path of insertion parallel with the long axis of the tooth will cause the contacts of the adjacent teeth to encroach on the path of insertion.

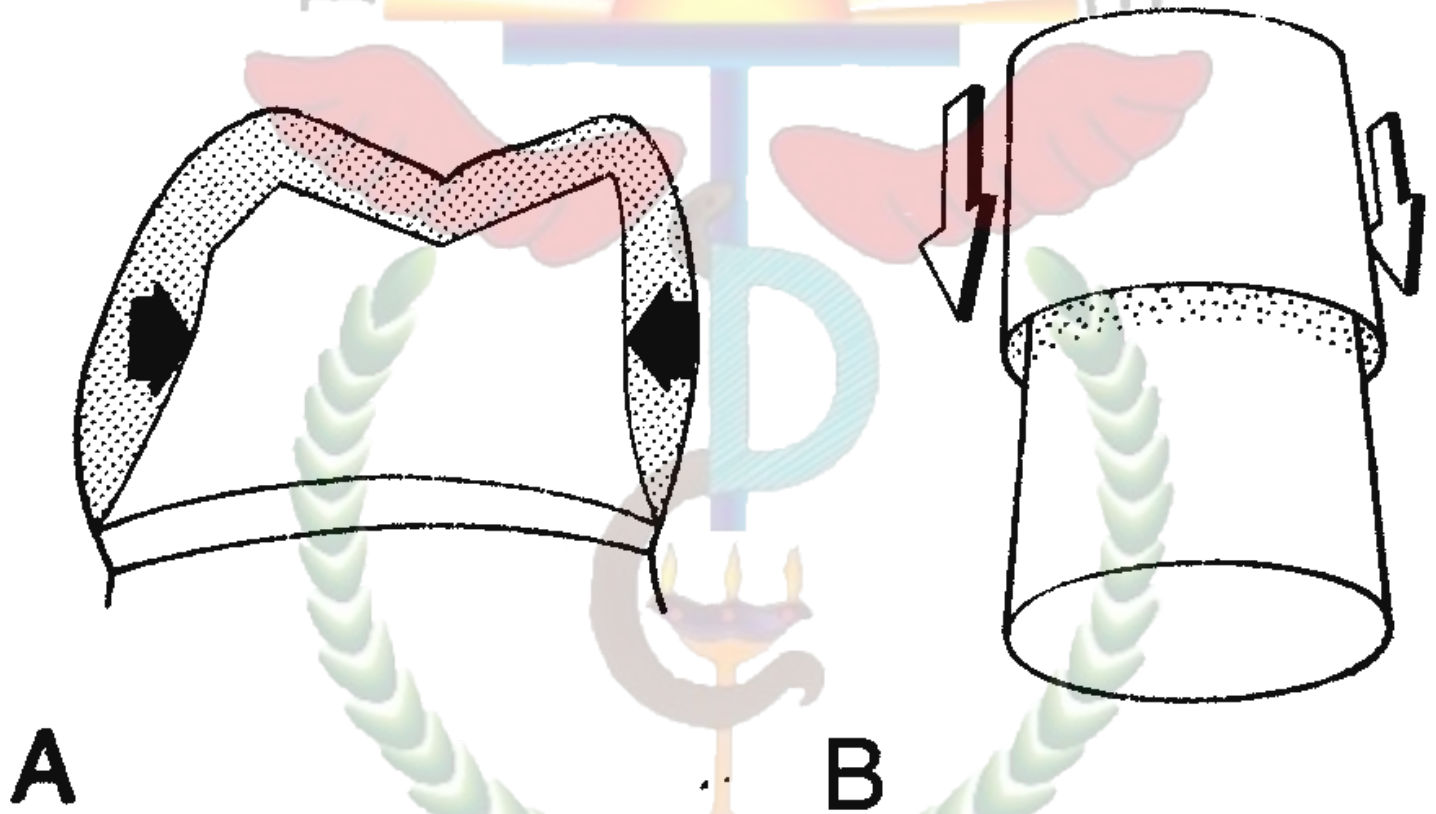


Taper :

Theoretically, maximum retention is obtained if a tooth preparation has parallel walls. However, it is impossible to prepare a tooth this way using current techniques and instrumentation.

A slight convergence, or taper, is necessary when preparing a tooth freehand. As long as this taper is small, the movement of the cemented restoration will be effectively restrained by the preparation and will have what is known as a limited path of withdrawal. However, as the taper increases so does the free movement of the restoration, and the retention is diminished.

Selection of the appropriate degree of taper for tooth preparation involves compromise. Too small a taper may lead to unwanted undercuts; too large a taper compromise retention. The relationship of one wall of a preparation to the long axis of that preparation is the inclination of that wall.



Tooth preparation taper should be kept minimal because of its adverse effect on retention. Minimum taper of 12 degree is necessary just to ensure the absence of undercuts. The tendency to over taper preparations must be avoided in order to achieve maximum retention. Consciously attempting to cut a taper can easily result in an over tapered and nonretentive preparation. A taper or total convergence of 16 degrees has been proposed as being achievable clinically while still affording adequate retention. This is probably in acceptable overall target. It can be as low as 10 degrees for preparations on anterior teeth and as high as 22 degrees on molars.

Prothero (1923) indicated that convergence of peripheral surfaces should range from 2^0-5^0.

Jorgensen (1955) found that retention decreases as the taper increases. A range of 2-6.5^0 has been considered to be optimal. He tested the retention of crowns at various TOC angles by applying a tensile force on cemented crown. Maximum strength was obtained at 5^0.

Mack (1980) estimated that a minimum taper of 12^0 is necessary just to ensure the absence of undercuts. The tendency to over taper preparations must be avoided in order to achieve maximum retention.

Ebnashi (1969) to minimize stress in the cement interface between the preparation and restoration, a taper of 2.5 to 6.5^0 has been suggested optimum, but there is only a slight increase in stress as taper is increased from 0 to 15^0. However at 20^0 stress concentration was found to increase sharply.

Surface area :

- Retention is mainly dependent on the surface area of the prepared tooth in sliding contact.
- The crowns with long axial walls are more retentive than those with short axial walls.
- Molar crowns are more retentive than premolars of similar taper.

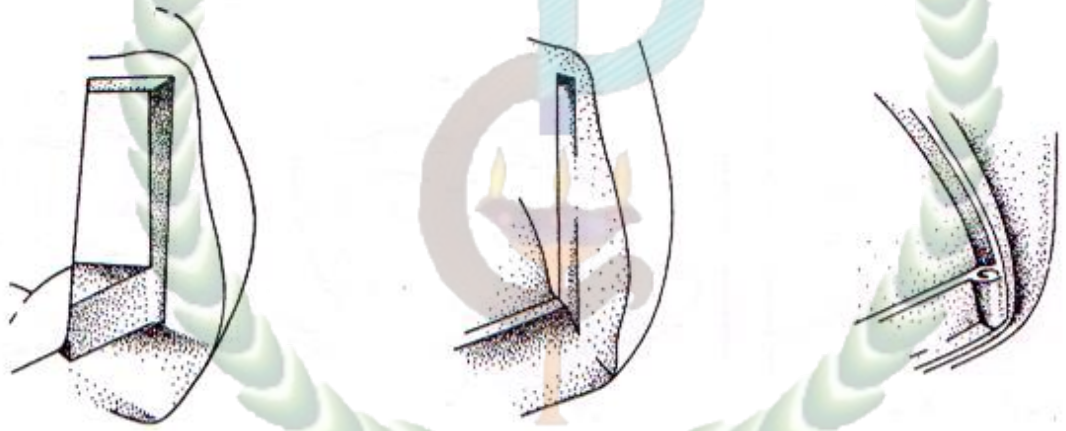
Stress concentration :

When a retentive failure occurs, cement is often found adhering to both the tooth preparation and the fitting surface of the restoration. In these cases cohesive failure has occurred through the cement layer because the strength of cement was less than the induced stresses. A computerized analysis of these stresses has revealed that they are not uniform throughout the cement but are concentrated around the junction of the axial and occlusal surfaces. It has been predicted that changes in geometry of the preparation (e.g. rounding the internal line angles) may reduce stress concentrations and hence increase the retention of the restoration.

Types of preparation :

Different types of preparations have different retentive values and these correspond fairly closely to the surface area of the axial walls, provided other factors (e.g. taper) are kept constant. Thus the retention of full veneer crowns are almost double that of partial coverage restorations.

Adding grooves or boxes to a preparation with a limited path of withdrawal does not markedly affect its retention because the surface area is not increased significantly. However other authors have reported that, where the addition of grooves or boxes limits the path of withdrawal, retention is increased.



Roughness of the surfaces being cemented :

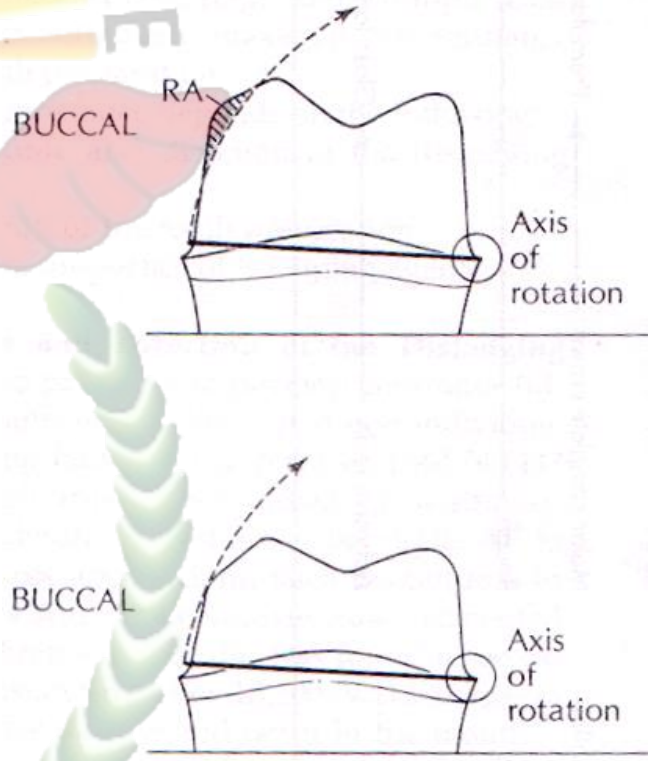
When the internal surface of a restoration is very smooth, retentive failure occurs not through the cement but rather at the cement-restoration interface. Under these circumstances retention will be increased if the restoration is roughened or grooved. The casting is best prepared by air-abrading the fitting surface with 50 μm alumina. This should be done carefully to avoid abrading the polished surfaces and margins. Air abrasion has been shown to increase the retention of castings by 64%.

RESISTANCE FORM

Adequate resistance depends on the following factors :

1. Magnitude and direction of the dislodging forces :

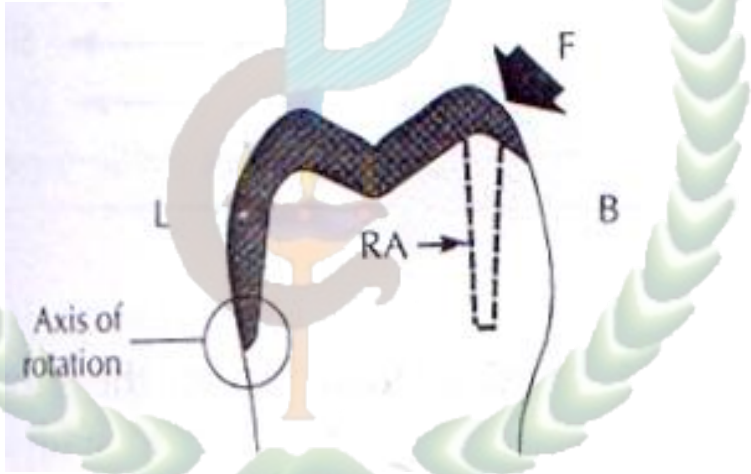
Some patients can develop enormous biting forces. Restorations should be made to withstand these forces. In a normal occlusion, biting force is distributed over the teeth, most of it is axially directed. If a fixed prosthesis is carefully made with a properly designed occlusion, the load should be well distributed and favorably directed. However if a patient has parafunctional habits such as pipe smoking or bruxing, it may be difficult to prevent fairly large oblique forces from being applied to a restoration. Consequently, the completed tooth preparation and restoration must be able to withstand considerably oblique forces as well as the normal axial ones.



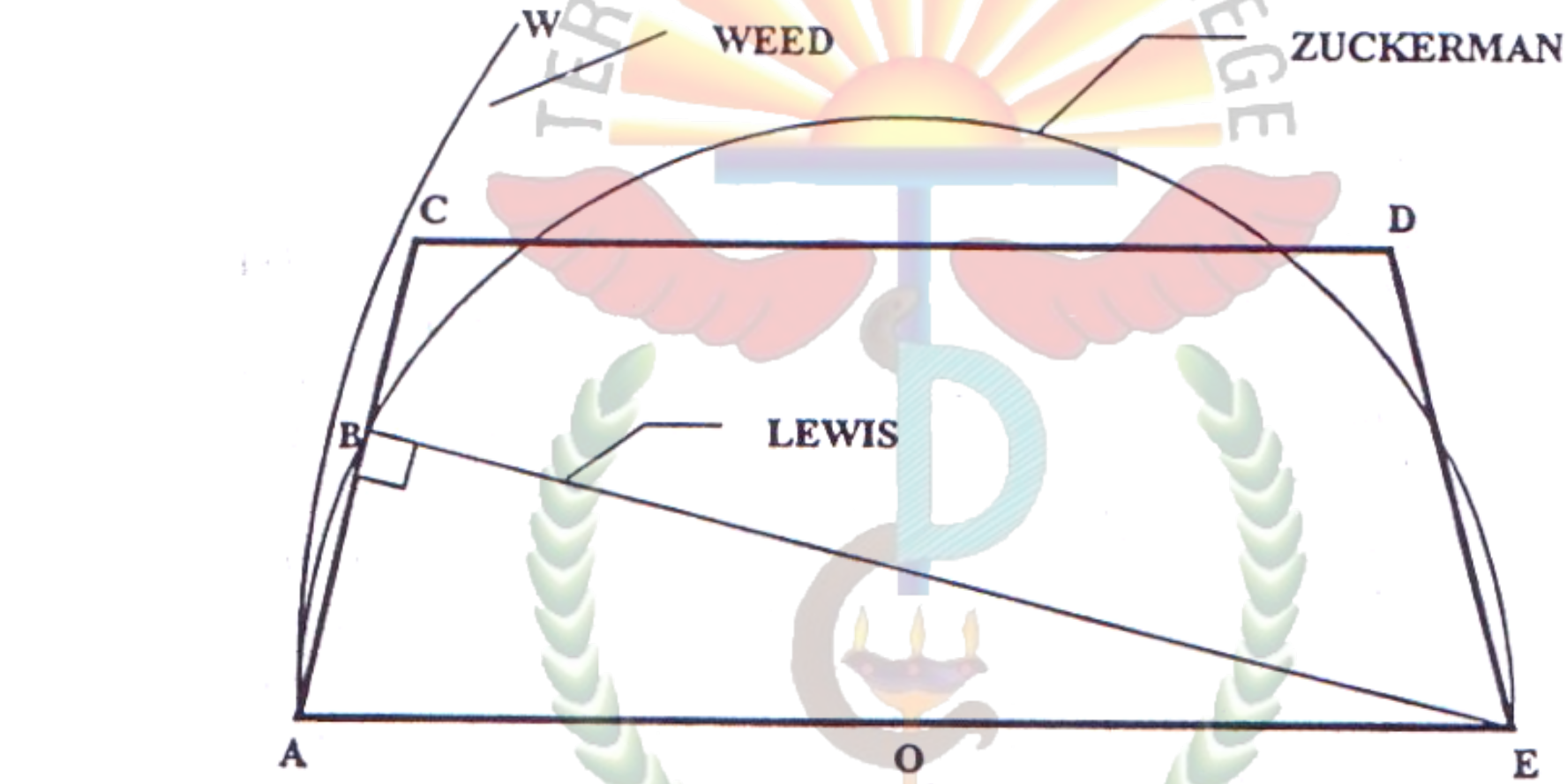
2. Geometry of the tooth preparation :

Preparation geometry plays key role in attaining desirable resistance form. The tooth preparation must be so shaped that particular areas of the axial wall will prevent rotation of the crown. Short tooth preparations with large diameters were found to have very little resistance form.

A partial coverage restoration has considerably less resistance than a complete crown because it has no buccal resistance areas. Resistance must be provided by boxes or grooves, and resistance will be the greatest if these have walls that are perpendicular to the direction of the applied force.



METHOD TO ANALYZE THE RESISTANCE FORM



Woolsey Matich (1978), Maxwall (1991) tested the resistance of artifical crowns that were 1,2,3 and 5 mm in OC dimension and had minimal (6^0) TOC. They concluded that 3 mm was minimal OC dimension required to provide adequate resistance for crowns made to fit teeth the size of maxillary incisal and mandibular premoalrs.

Goodacre (2001) proposed that 3 mm is minimal OC dimension for premolars and anterior teeth that are prepared within the recommended TOC range of $10\text{-}20^0$. Because the molars are prepared with greater TOC than anterior teeth have a greater diameter than other teeth and located where the occlusal forces greater. 4 mm is proposed as the minimal OC dimension. Teeth that do not have these minimal dimensions should be modified with auxilliary resistance features such as grooves / boxes.

Hegdahl and Silness (1977) compared the areas that created resistance form on conical and pyramidal tooth preparations. The pyramidal tooth provided increased resistance because they possess corners when compared with conical preparations. Teeth that lack natural circumferential morphologic variations after tooth preparations (round teeth) should be modified with the creation of grooves or boxes in axial surfaces.

3. Physical properties of the luting agent :

Resistance to deformation is affected by physical properties of the luting agent such as compressive strength and modulus of elasticity. To satisfy ADA specification No. 8, the compressive strength of zinc phosphate cement must exceed 70MPa at 24 hours. Glass ionomer, resin, polycarboxylate and reinforced ZOE all have lower values. In practical terms this means that reinforced ZOE cement should be used with caution as permanent luting agent, being reserved for situations in which their superior biologic properties outweigh their lower strength.

Zinc phosphate cements have a higher modulus of elasticity than do polycarboxylate cements, which exhibit relatively large plastic deformation. This may account for the observation that the retentive ability of polycarboxylate cement is more dependent on the taper of the preparation than is the retention with zinc phosphate cement.

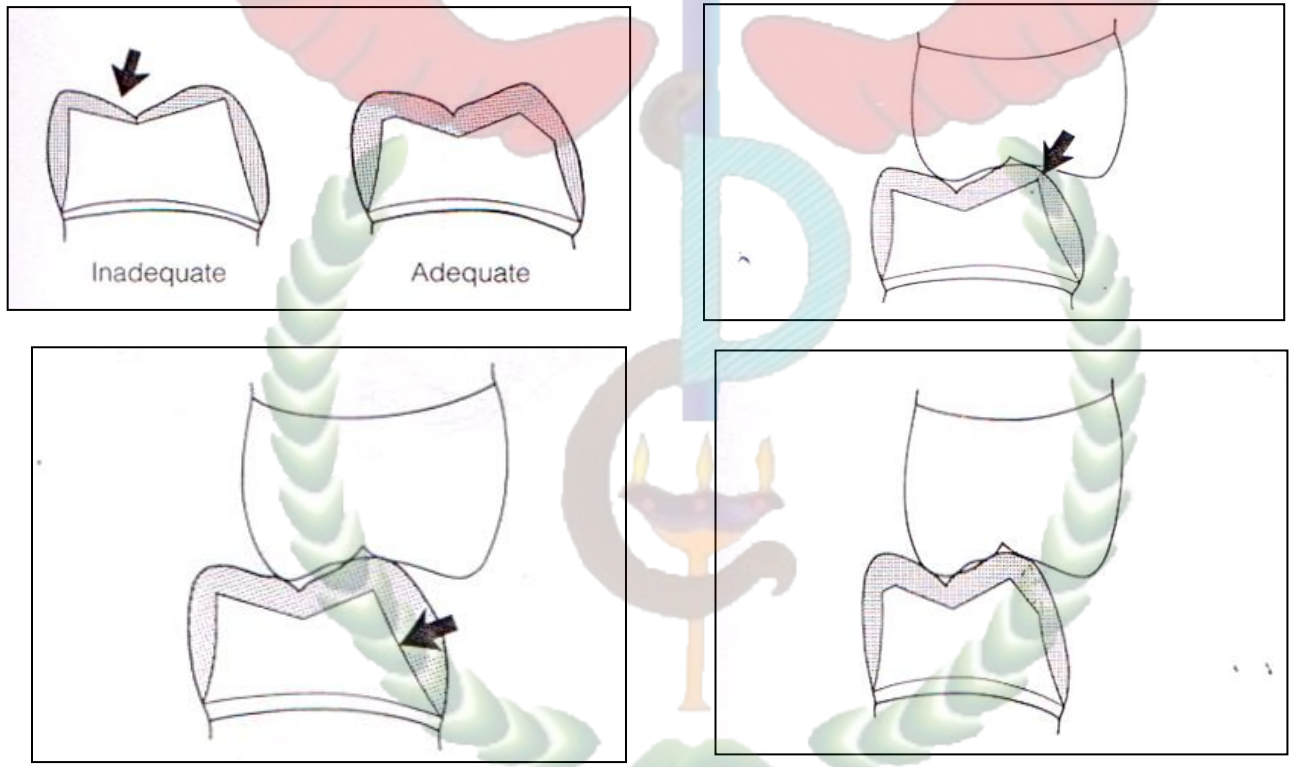
STRUCTURAL DURABILITY

1. Occlusal reduction :

- Once of the most important features for providing adequate bulk of metal and strength to the restoration is occlusal clearance.
- For gold alloys there should be 1.5 mm of clearance on the functional cusps, and 1.0 mm on the non-functional cusps.
- Metal ceramic crowns will require 1.5 to 2.0 mm on functional cusps that will be veneered with porcelain and 1.0 to 1.5 mm on non-functional cups to receive ceramic coverage.
- There should be 2.0 mm of clearance on preparations for all ceramic crowns.
- Malposed teeth may have occlusal surfaces that are not parallel with the occlusal table. So accordingly less or more reduction may be required to achieve the requisite clearance.

2. Functional Cups Bevel :

The functional cusp bevel is an integral part of the occlusal reduction. A wide bevel on the lingual inclines of the maxillary lingual cusp and the buccal inclines of the mandibular buccal cusps provides space for an adequate bulk of metal in an area of heavy occlusal contact.



3. Axial Reduction :

Axial reduction also plays an important role in securing space for an adequate thickness of restorative material. If restorations are made with normal contours over preparations with inadequate axial reduction, they will have thin walls that will be subjected to distortion. Any overcontouring of the restoration to compensate for inadequate axial reduction will compromise the health of the periodontium.

MARGINAL INTEGRITY

The restoration can survive in the biological environment of the oral cavity if the margins are closely adapted to the cavosuraface finish line of the preparation. The configuration of the preparation finish line dictates the shape and bulk of restorative material in the margin of the restoration. It can also affect both the marginal adaptation and degree of seating of the restoration.

FINISH LINE REQUIREMENTS:

Definition:

The point at which a preparation terminates on the tooth is called the finish line. It is also defined as the peripheral extension of a tooth preparation (GPT 2000).

Functions :

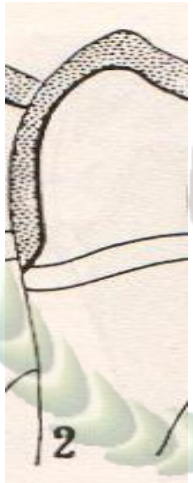
The finish line serves the following functions :

- During visual evaluation of the tooth preparation, it is a measure of the amount of tooth structure already removed. It also delineates the extent of the cut in an apical direction. The more distinct it is, the better it serves these purposes.
- The finish line is one of the features that can be used to evaluate the accuracy of the impression made for indirect procedures.
- In the die, a distinct finish line helps to evaluate the quality of the die and helps in accurate die trimming.
- The correct marginal adaptation of the wax pattern depends on an obvious finish line.
- The evaluation of the restoration is also aided by a proper finish line.
- At cementation, a sharp finish line aids in determining whether the restoration is fully seated.

TYPES OF FINISH LINES

Chamfer finish line :

The preferred finish line for the veneer metal restorations is the chamfer. This finish line has been shown experimentally to exhibit the least stress, so that the cement underlying it will less likelihood of failure. It can be cut with the tip of a round end diamond, while the axial reduction is being done with the side of that instrument. However, a torpedo diamond is less likely to produce a butt joint. The margin of the cast restoration that fits against it combines an acute edge with a nearby bulk of metal.



Heavy chamfer finish line :

A heavy chamfer is used to provide a 90-degree cavosurface angle with a large radius rounded internal angle. It is created with a round end tapered diamond. In the hands of an unskilled operator, this instrument can create an undesirable fragile lip of enamel at the cavosurface. The heavy chamfer provides better support for a ceramic crown than does a conventional chamfer, but it is as good as a shoulder. A bevel can be added to the heavy chamfer for use with a metal ceramic restoration.

Shoulder :

The shoulder has long been the finish line of choice for the all-ceramic crowns. The wide ledge provides resistance to occlusal forces and minimizes stresses that might lead to fracture of the porcelain. It produces the space for healthy restoration contours and maximum esthetics. However, it does require destruction of more tooth structure than any other finish line, the sharp 90-degree internal line angle associated with the classic variety of this finish line concentrates stress in the tooth and is conductive to coronal fracture. The shoulder generally is not used as a finish line for cast metal restorations.

Shoulder with bevel :

The shoulder with a bevel is a used as a finish line in a variety of situations. It is utilized as the gingival finish line on the proximal box of inlays and onlays, and for the occlusal shoulder of onlays and mandibular three quarter crowns. This design can also be used for the facial finish line of metal ceramic restorations where gingival esthetics is not critical. It can be used in those situations where a shoulder is already present, either because of destruction by caries or the presence of previous restorations. It is also a good finish line for preparations with extremely short walls, since it facilities axial walls that are nearly parallel.

The objectives of beveling is threefold :

1. To allow the cast metal margin to be bent or burnished against the prepared tooth structure.
2. To minimize the marginal discrepancy caused by a complete crown that fails to seat completely. However this is controversial and is challenged by several authors.
3. To protect the unprepared tooth structure from chipping (e.g. by removing unsupported enamel).

Knife-edge :

The knife-edge margin provides for an acute margin of metal. But its use can create problems. Unless it is carefully prepared, the axial reduction may fade out instead of terminating in a definite finish line. The thin margin of the restoration that fits this finish line may be difficult to accurately wax and cast. It is also more susceptible to distortion in the mouth when the casing is subject to occlusal forces.

The use of the knife-edge can result in over contoured restorations when an attempt is made to obtain adequate bulk by adding to the external axial contours of the restoration. However, it is sometimes necessary to use the knife-edge. It may have to be used on the lingual surface of mandibular posterior teeth, on teeth with very convex axial surfaces, and the surface toward which a tooth may have tilted.

Featheredge :

A featheredge finish line is unacceptable because it is not sufficiently distinct and results in so little cervical tooth reduction that the restoration must be over contoured to possess adequate rigidity. Also, since a feather edge is more difficult to see visually, occlusocervical undulations and irregularities in the finish line are more likely to be present, making it much more difficult to fabricate a restoration that fits accurately.

ESTHETIC CONSIDERATIONS

The restorative dentist should develop skill in determining the esthetic expectations of the patient. Patients prefer their dental restorations to look as natural as possible. However, care must be taken that the esthetic considerations are not preserved at the expense of the patient's long term oral health or functional efficiency.

Whenever possible, accomplishment of an esthetically acceptable result without the use of metal-ceramic crowns is preferred, not only because tooth structure is conserved but also because no restorative material can approach the appearance of intact tooth enamel.

Partial coverage restorations :

Esthetically partial – coverage restorations depend on accurate placement of the potentially visible facial and proximal margins. If a partial coverage restoration in poorly prepared, the patient may demand that it be replaced by a metal-ceramic crown and the result will be unnecessary loss of tooth structure and a greater potential for tissue damage.

Proximal margin :

Placement of the proximal margins is critical to the esthetic result of a partial – coverage restoration. The rule here is to place the margin just buccal to the proximal contact area, where metal will be hidden by the distal line angle of the neighboring tooth. Tooth preparation angulation is critical and should normally follow the long axes of posterior teeth and the incisal two thirds of the facial surface of anterior. If a buccal or lingual tilt is given to the preparation, metal will be visible.

Facial margin :

The facial margin of a maxillary partial coverage restoration should be extended just beyond the occlusofacial line angle. A short bevel in needed to prevent enamel chipping. A chamfer can be placed where appearance is less important, because this will provide greater bulk of metal for strength.

If the buccal margin of metal is correctly shaped, it will not reflect light to an observer. As a result, the tooth will appear to be merely a little short than normal rather than as though its buccal cusp is outlined in metal. If the buccal margin is skillfully placed following the original cuspal contour, the final restoration will have an acceptable appearance.

When mandibular partial coverage crowns are made, metal display is unavoidable because the occlusal surface of the mandibular teeth can be seen during speech. A chamfer, rather than a bevel, is recommended for the buccal margin because it provides a greater bulk of metal around the highly stressed centric cusp. If the appearance of metal is unacceptable to the patient, a metal ceramic restoration with porcelain coverage on the occlusal surface can be made.

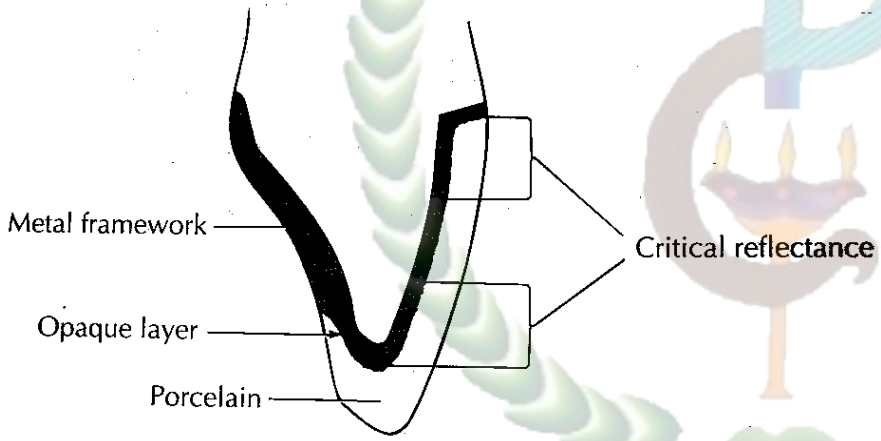
Anterior partial coverage restorations can be fabricated to show no metal, but their preparation requires considerable care. The facial margin is extended just beyond the highest contour of the incisal edge but not quite to the incisolabial line angle. Here the metal will protect the tooth from chipping but will not be visible.

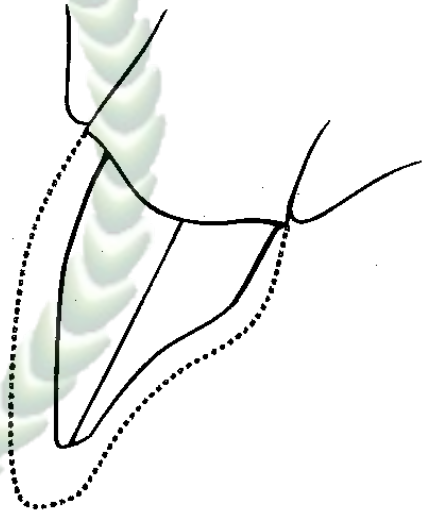
Metal ceramic restorations :

The poor appearance of some metal ceramic restorations is often due to insufficient thickness of porcelain. On the other hand, adequate thickness of porcelain is sometimes obtained at the expense of proper axial contour. In addition, the labial margin of a metal ceramic crown is not always accurately placed. To correct all these deficiencies, certain principles are recommended during tooth preparation that will ensure sufficient room for porcelain and accurate placement of the margins. Otherwise good appearance would be achievable only at the expense of periodontal health.

Facial tooth reduction :

If there is to be sufficient bulk of porcelain for appearance and metal for strength, adequate reduction of the facial surface is essential. A minimum reduction of 1.5 mm typically is required for optimal appearance. Adequate thickness of porcelain is needed to create a sense of color depth and translucency. Shade problems are frequently encountered in maxillary incisor crowns at the incisal and cervical thirds of the restorations, where direct light reflection from the opaque layer can make the restoration appear very noticeable. Because opaque porcelains generally have a different shade from body porcelains, they often need to be modified with special stains in these areas.





With very thin teeth (e.g. mandibular incisors) it may be impossible to achieve adequate tooth reduction without exposing the pulp or leaving a severely weakened tooth preparation. Under these circumstances a less than ideal appearance may have to be accepted.

The labial surfaces of anterior teeth should be prepared for metal ceramic restorations in two distinct planes. If they are prepared in a single plane, insufficient reduction in either the cervical or the incisal area of the preparation will result.

Incisal reduction :

The incisal edge of a metal ceramic restoration has no metal backing and can be made with a translucency similar to that of natural tooth. An incisal reduction of 2 mm is recommend for good esthetics. Excessive incisal reduction must be avoided because it reduces the resistance and retention form of the preparation.

Proximal reduction :

The extent of proximal reduction is contingent on exact predetermination of the location of the metal –ceramic junction in the completed restoration. The proximal surfaces of anterior teeth will look more natural if they are restored as the incisal edges without metal backing. This will allow some light to pass through the restoration in a manner similar to what occurs in a natural tooth. But if the restoration is the part of a fixed partial denture, the need for connectors will make this impossible.

Labial margin placement :

Supragingival margin placement has many biologic advantages. The restorations are easier to prepare properly and easier to keep clean. Nevertheless, subgingival margins may be indicated for esthetic reasons, particularly when the patient has a high lip line and the use of a metal collar labial margin is contemplated.

Patients with a high lip line, exposing considerable gingival tissue, present the greatest problem if complete crowns are needed. Where the root surface is not discolored, appearance can be restored with a metal ceramic restoration having a supragingival porcelain labial margin – sometimes called a “collar less” design. If the patient has a low lip line, it may be acceptable to place a metal supragingival collar because the metal is not seen during normal function. Metal margins generally have a more accurate fit then do porcelain margins. However, some patients may have reservations about exposed metal, and the advantages of supragingival margins must be explained to the patient.

Margin should not be placed as far apically that they encroach on the attachment; extension within 1.5 mm of the alveolar crest will lead to bone resorption. The margin should follow the contour of the free gingiva, being further apical in the middle of the tooth and further incisal interproximally. A common error is to prepare the tooth so that the margin lies almost in one plane, with exposure of the collar labially and irreversible loss of bone and papilla proximally.

Charles J Goodacre. DCNA 2004, V-48, 359-385.

Made study on designing tooth preparation for optimal success.

Following guidelines are proposed,

1. The TOC (Total Occlusal Convergence) ranges between 10 to 20^{0}. When TOC exceeds preparation should be modified with boxes and grooves.

2. 3 mm should be IC/OC (Incisocervical or Occlusocervical) dimension for anterior and premolars. 4 mm for molars within recommended TOC of 10 to 20^{0}.

3. When auxillary preparation are placed into teeth preferred location are proximal surfaces.

4. Finish line should be placed supragingivally. If subgingival finish lines are placed not extended to the epithelial attachment.

5. For metal ceramic crowns finish line selection should be based on formation ease, personal preference, esthetic requirement, and type of crown being fabricated rather than on expectations of enhanced marginal fit with one type of finish line compared with the others.

6. Rounded line angles on tooth preparation for all ceramic crown decrease the stress placed on the crowns and increases the longevity.

7. Retention of tooth preparation appears to be related to type of cement used. Surface roughness increases the retention with zinc phosphate cement but no definite relationship has been established when crowns are cemented with zinc polycarboxylate, GIC and resin. It therefore seems appropriate to recommend that teeth to be prepared with reasonable degree of surface smoothness.

Diagnostic tooth preparations :

Diagnostic tooth preparations are performed on articulated casts before the actual clinical preparation. They yield information with regard to:

1. Selecting the appropriate path of withdrawal of a fixed partial denture, particularly when the abutment teeth are fluted or have an atypical coronal contour.
2. Determining the best location for the facial and proximal margins of a partial coverage restoration so the metal will not be visible.
3. Deciding the amount of tooth reduction necessary to accomplish a planned change in the occlusion.
4. For prefabrication of temporary restorations.

Diagnostic waxing procedures :

It is recommended for all but the most straight forward prosthodontic treatment a diagnostic waxing procedure be performed. This is done on diagnostic tooth preparations and establishes the optimum contours and occlusion of the eventual prosthesis. The procedure is of particular benefit if the patient's occlusal scheme or anterior (incisal) guidance requires alteration.

Common errors of tooth preparation :

1. Insufficient occlusal or incisal reduction.
2. Lack of uniform reduction of labial or buccal surfaces compromising esthetics.
3. Minimum axial reduction on the buccal and lingual surface of the posterior teeth, which increases the incidence of working prematurities. The distinction between reduction and clearance is crucial. a
4. Inappropriate proximal reduction, which prevents having a cleanable embrasure space.
5. Over reduction of teeth and/or violation of the biologic width.
6. Insufficient gingival reduction to accommodate a definite finish line.
7. Undercuts on the distolingual surface of the preparation and/or lack of parallelism of the FPD abutments.
8. Failure to contour proximal surfaces of adjacent teeth to allow seating of a restorations.

Take home message

- Mechanical, biologic and esthetic principles of tooth prep all play equal role in a successful FPD.

CONCLUSION

The principles of tooth preparation can be categorized into biological,mechanical,esthetic considerations.It is important to understand the pertinent theories underlying each step .Successful preparation can be obtained by systematically following these steps.It is important to critically evaluate each step.

PROBABLE SAQS AND LAQS

- LAQ
- What are the principles of tooth preparation
- SAQ
- Explain different types of finish lines
- Advantages and disadvantages of chamfer finish line

THANK YOU