Cavity Preparations

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Introduction

When teeth develop carious lesions or undergo fracture or loss of substance due to abrasion or erosion, cavity preparation is warranted. This will permit placement of a material that will restore the tooth's original form and function. Cavity preparation designs vary according to extent of damage and the type of restorative material to be used. Special drilling instruments are used at varying speeds in combination with hand instruments for cavity preparation. The challenge with cavity preparations is that they must be completed with great care so that all important design features are incorporated while at the same time avoiding encroachment onto the underlying vital pulpal tissues which are contained as a core within the teeth.

Materials used for restoration of teeth can generally be divided into two categories: ones that are placed directly into a prepared cavity such as amalgam and resin composite; and ones that are made to a stone cast of the cavity and later cemented with special cement such as cast gold and porcelain. However, for economical reasons, the directly-placed restorations represent the majority of restorations used by dentists worldwide.

Background

Carious lesions develop when certain types of bacteria found in the mouth (streptococcus mutans) metabolize carbohydrates left over from food debris to form acids. These attack the surfaces of the teeth and slowly cause demineralization through the loss of calcium and phosphorous with subsequent formation of carious lesions. Lesions develop on any tooth surface and start at the outer surface of enamel slowly progressing towards dentin. A cavity is fully-formed once the lesion passes through the dentin-enamel junction into dentin. Over a century ago, Black, who is considered to be the father of operative dentistry, classified

carious lesions into 5 different classes, with one class, class 6, later added. These classes are based on the surface(s) they involve.[1] Black's original classification continues to be used globally for education at the present time.

When a cavity is prepared to remove a carious lesion it is typically slightly larger than the size of the lesion itself. On the tooth surface it has an outline form which refers to the perimeter of the cavity. This is also usually a little larger than the perimeter of the carious lesion. The cavity must have subtle features incorporated in its form to ensure longevity of the restoration. These features are typically referred to as retention and resistance forms. Retention forms represent features that enable a cavity to retain a restoration in place without movement. For example, if one was to think of a Class I cavity as resembling a box, when the base of the box (pupal floor) is slightly wider than its opening (occlusal) there is virtually no means for a restoration placed in such a cavity to get dislodged in one piece. Resistance forms refer to the cavity design that prevents fracture of either the restoration or the tooth itself. For example, amalgam is a brittle material and if used in thicknesses less than 2 mm it may undergo fracture under loads of mastication. Therefore, a cavity prepared for amalgam restoration must provide for adequate amalgam thickness on the occlusal of at least 2 mm. Enamel is highly brittle, however, dentin which is softer acts as a cushion to support enamel and prevent its fracture. If an enamel margin was left unsupported during cavity preparation for amalgam, it may undergo fracture under forces of mastication.

For many years cavities have been prepared using a combination of slow-speed rotary and hand instruments. In the late 1950s high-speed rotary instruments were introduced to the profession. These are air turbine-driven and rotate at speeds exceeding 400,000 rpm.[2,3] Air-water spray is integrated with these handpieces to ensure proper cooling and prevent over-heating of tooth tissues. When tungsten carbide burs are used in these handpieces, cavity preparation can be swiftly completed due to the high efficiency of these burs. Diamond burs may alternatively be used for intra-coronal cavity preparation. Slow-speed handpieces, with rotating speed ranging from 500 to 15,000 rpm, are used with steel burs for removal of soft decayed dentin, refinement and finishing of cavities. When cavity preparation is complete, cavities are rinsed with water and cleaned of any remaining debris in preparation for the restoration. While other techniques for cavity preparation were developed by the industry over the years, such as air-abrasion and laser, their use, however, never gained popularity due to their inherent limitations.[4]

Procedure

Class I cavities

Class I involves pits and fissure caries (occlusal surfaces of posterior teeth, lingual pits of upper incisors and buccal/lingual pits of molars). Cavity preparation begins once the extent of the damage that took place is assessed and the outline form to be created has been

determined. Typically, direct clinical examination combined with the analysis of bitewing radiographic images is necessary for such assessment. However, in the early stages of Class I caries, radiographic images are not useful. On a lower molar, for example, if the carious lesion was found to involve all of the fissures on the occlusal surface, a pear-shaped bur, tungsten carbide # 245, is used in a high-speed handpiece with profound water-cooling to first establish cavity depth. The bur is dropped at the central fossa location until a depth of less than 2 mm is established. The bur is then moved along the central developmental groove from mesial to distal, back and forth, in order to remove carious dental tissues. At the same time, this will establish the cavity outline. The buccal and lingual developmental grooves are then similarly engaged to complete the removal of the caries. The pear-shaped bur is selected as it helps in providing the buccal and lingual walls of the cavity with a subtle convergence towards the occlusal opening (undercut effect). This will automatically create a cavity base that is slightly wider than the occlusal opening necessary for retaining the restoration in place (retention form). If the carious lesion has extended in certain areas beyond 2 mm in depth, a spoon excavator is carefully used to remove the decayed dentin. This results in the formation of the subfloor, which is typically a rounded concavity that extends beyond the pulpal floor level. A large-size round bur is used in a slow-speed handpiece to finish the subfloor and remove any remaining decayed dentin. Slow-speed burs are then used for finishing and refining the cavity walls and floor.

Occasionally, an occlusal carious lesion is interconnected with another one on the buccal or lingual surface. A Class I cavity with a buccal or lingual extension is then prepared. The extension may or may not include preparation of a step depending on the extent of the lesion. For example if the lesion on buccal or lingual surface was located below the level of the pulpal floor, preparation of a step is warranted.

Class II cavities

Class II carious lesions occur on proximal surfaces of premolars and molars. They may occur in combination with occlusal (Class I) caries or they may occur alone. In situations where the presence of caries is on the occlusal as well as the proximal surface, a two-surface cavity is prepared. However, in order to gain access to the proximal carious lesion, the dentist frequently has to break through an otherwise healthy marginal ridge. This is referred to as “convenience form” since there is no other way to reach such lesions for thorough removal of caries. The proximal part of the cavity that is formed in this process is referred to as the proximal box. It has a floor (gingival) and walls (buccal, lingual and axial). The floor is ideally slightly larger than the occlusal opening, to provide retention against vertical displacement (undercut effect). In addition, since the proximal box has only three walls, accessory retentive measures may be incorporated to prevent horizontal sliding of the proximal portion of the restoration out of the box. Retention grooves are made with a small round bur (1/4 round) at strategic locations in the box (axiobuccal and axiolingual lineagles) for this purpose. On some teeth, such as maxillary molars for example, when an oblique

ridge is not involved, a dovetail outline is followed on the occlusal portion of the Class II cavity to provide retention against horizontal displacement of the proximal portion of the restoration.

The axiopulpal lineangle, formed through the connection of the proximal box with the occlusal cavity, must be rounded off in order to prevent stress concentration in an amalgam restoration. That may lead, in the long term, to isthmus fracture. Another resistance feature incorporated in the proximal box is beveling of the gingival cavo-surface margin. This is in order to remove unsupported enamel rods that may otherwise fracture off under forces of mastication, leaving a gap at this critical margin.

When a Class II carious lesion exists without involvement of the occlusal, a slot cavity is prepared which is essentially the proximal portion of the Class II preparation. In such cases, it is extremely important to place retention grooves at the lineangles since in the absence of the occlusal portion these become the only means of retention against horizontal displacement.

Potentially, a large Class II cavity may involve all five surfaces of molars. This occurs when there are carious lesions on both proximal surfaces and when the occlusal caries is extending buccally and lingually through the grooves. In more extensive cases where there is loss of one or more cusps additional means of retention, such as placement of pins, might be warranted.

Class III cavities

Class III carious lesions occur on the proximal surfaces of incisors and canines. They are typically restored with resin composite, with the exception of cavities on distal surfaces of canines which may be alternatively restored with amalgam. A Class III cavity typically involves the lingual or buccal surface for access to the carious lesion. In more extensive lesions both lingual and buccal surfaces are involved. A smaller pear-shaped tugsten carbide bur (#330) is used in a high-speed handpiece for their preparation. If the lesion is limited to the proximal surface, access is typically gained through the lingual surface in order to maintain continuity of the labial surface. The cavity is essentially box shaped with a floor (axial) and three walls (gingival, incisal and labial or lingual depending on access direction). Accessible cavo-surface margin receives a ½ mm bevel to enhance the surface area available for bonding and provide an improved seal.

Class IV cavities

Class IV carious lesions occur on the proximal surfaces of incisors and canines and involve the incisal angles. They take place under two case scenarios: if a Class III lesion is left untreated it may extend incisally until it involves the incisal angle, or when teeth, most frequently maxillary centrals and laterals, are subjected to impact fracture in domestic

accidents leading to formation of Class IV lesions.
Class IV cavities are restored with resin composite. In the case of accidental fracture, cavity preparation is typically limited to providing a wide 2 mm all-around bevel of enamel cavo-surface margin. This provides sufficient retention for the restoration through bonding. Extensive Class IV restorations involve all five tooth surfaces. In the case of a Class III carious lesion that has progressed to involve the incisal angle, the carious lesion is first removed and a retention groove may be placed at the gingivo-axial lineangle. The cavo-surface margin is then beveled as above.

Class V cavities

Class V lesions occur on the cervical 1/3 of the labial surfaces of incisors and canines; and on the buccal and lingual surfaces of premolars and molars. They take place under two case scenarios; through the formation of caries or through the loss of tooth substance due to abrasion/erosion. Abrasion/erosion lesions judged to be shallow are not restored. On incisors, canines and premolars, Class V cavities are typically restored with resin composite, however, on molars they are either restored with resin composite or amalgam. Resin-modified glass ionomer can also be used for their restoration, however, resin composite provides superior esthetics.

Class V cavities are essentially box-shaped with a floor (pulpal) and four walls (occlusal, cervical, mesial and distal).When amalgam is used retention grooves are placed along the occluso-pulpal and cervico-pulpal lineangles. When resin composite is used the cavo-surface margin receives a ½ mm all-around bevel to increase surface area available for bonding and to provide a better seal.

Class VI cavities

Class VI lesions occur on incisal surfaces of anterior teeth and cusp tips of canines, premolars and molars due to attrition. Typically the lesion will have the appearance of a worn down central dentin island surrounded with ragged enamel periphery. They can be restored with either resin composite or amalgam for posterior teeth. Cavity preparation is essentially a box in form with floor (pulpal) and four walls. When the cavity is shallow, it is recommended to use resin composite since it does not carry the same risk of fracture under occlusal loads when used in thin sections as does amalgam. This is a great benefit considering that such lesions occur right on top of pulp horns.

Research and Clinical Implications

As long as adequate air/water cooling spray is maintained throughout high-speed cavity preparation, overheating of teeth never takes place. Light intermittent pressure and the use of sharp new burs while drilling helps to avoid overheating. Frequent rinsing and removal of tooth debris is another factor in avoiding heat buildup during cavity preparation particularly

when using slow-speed burs.
Research has shown that when internal lineangles of cavities are prepared rounded, instead of sharp, it results in the elimination of stress-concentration zones. As a result, this helps in preventing the possibility of cuspal fracture or amalgam fracture by ensuring even distribution of stresses generated during mastication.
Research has also shown that when preparing premolars for MOD (mesio-occluso-distal) amalgam restorations, it is better to prepare two separate slot cavities if the occlusal was not involved with caries. This maintains a connection between the buccal and lingual cusps which prevents their fracture.[5]

Contentious Issues

In the Class II cavity prepared for restoration with amalgam, the placement of retention grooves in the proximal box seems to be a controversial issue. Since it carries a fairly high risk of exposing pulp, particularly in the hands of the novice dentist, some authorities tend to think that the benefit gained from having retention grooves may not outweigh the risks involved in their placement.6 Moore DL concluded “Accessory retention in the form of grooves, slots, post holes or pins may be required for large restorations restoring cusps. However, the routine placement of approximal retention grooves in Class 2 amalgam preparations may be considered an unnecessary hazard”. [6] In addition in narrow proximal boxes, the placement of retention grooves is not essential.[7]

References

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