牙體復形學 Operative dentistry

Caries Management: Diagnosis and Treatment Strategies

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學習目標

- 期許同學在瞭解病患的需求及材料的特性後，能依據所學善加利用，做到不僅是幫病患解決病痛的牙醫師，同時也是個讓病患永遠也忘不了的藝術家。

1. 牙齒的生理，解剖形態
2. 齲齒的生理，診斷及治療計劃
3. 窩洞的修形及材料的選擇
4. 窩洞的充填方式及其修飾
5. 美觀性材料的選擇及其運用
6. 變色牙的修飾

參考資料

1. Sturdevant's art and science of operative dentistry. 4th edition. Theodore M. Roberson.
2. Fundamental of operative dentistry. A contemporary approach 3rd edition, James B. Summitt.

Summary

Operative dentistry is the basic science in clinical dental practices.It included dental physiology,morphology,cariology,tooth preparation for restoration.The purpose of Operative dentistry is to complete the function and create the aethestic outlook.

Introduction

Traditional caries management has consisted of the detection of carious lesions followed by immediate restoration. In other words, caries was managed primarily by restorative dentistry. However, when the dentist takes the bur in hand, an irreversible process begins. Placing a restoration does nor guarantee a sound future for the tooth; on the contrary, it may be the start of a restorative cycle in which the restoration will be replaced several times. The decision to initiate invasive treatment should be preceded by a number of questions: Is caries present and if so, how far does it extend? Is a restoration required, or could the process be arrested by preventive treatment? Sometimes the decision to restore may be based on questionable diagnostic criteria.

Introduction

The introduction of adhesive restorative materials has allowed dentists to make smaller preparations, which has led to preservation of hard dental tissues and, along with declining disease prevalence, has allowed elimination of G. V. Black's principle of "extension for prevention." Maximum tooth structure is preserved. However, this approach, sometimes described as a "dynamic treatment concept," cannot prevent repeated treatment procedures and the occurrence of iatrogenic damage (Fig 4-1). Lussi and Gygax showed that during the preparation of a proximal surface, the neighboring surface was damaged 100% of the time, despite very careful operating procedures.

Introduction

A different treatment strategy is recommended, based on a proper diagnosis of caries, taking into account the dynamics of the caries process. The activity of caries should be determined, and causative factors should be evaluated. Caries risk should be assessed before treatment is considered, and treatment should include preventive regimens to arrest the caries process by redressing the imbalance between demineralization and remineralization.

Introduction

The treatment goal in caries management should be to prevent new lesions from forming and to detect lesions sufficiently early in the process so that they can be treated and arrested by nonoperative means, Such management requires skill and is time-consuming and worthy of appropriate payment. If these attempts have failed, high-quality restorative dentistry will be required to restore the integrity of the tooth surface.

Etiology

The factors involved in the caries process, which include the tooth, dental plaque, and diet, were presented in the 1960s in a model of overlapping circles. Since then, the model has been supplemented with the factors of time, fluoride, saliva, and social and demographic factors (Fig 4-2.). At first sight, these circles constitute a simple model to explain caries risk, which is represented by the overlap of the three inner circles. When one of the risk factors increases, the respective circle becomes larger, as does the overlap of the circles, indicating increased caries risk. If there is, for instance, hyposalivation, the saliva circle will tighten the three inner circles, enlarging the overlap, again indicating a greater risk. Inversely, the model explains why reduction in any risk factor decreases caries risk.

Dental Plaque

The prevalence of mutans streptococci and lactobacilli is associated with dental caries., Streptococcus mutans is involved in caries formation from its initiation, while lactobacilli are so-called secondary organisms that flourish in a carious environment and contribute to caries progression. Dental plaque may be more cariogenic locally where mutans streptococci and lactobacilli are concentrated, but in everyday practice it is difficult for the dentist to identify cariogenic plaque to make this knowledge useful in treating individual patients. Plaque can be sampled and mutans streptococci and lactobacilli can be quantified, but the procedure is quite complicated and requires the support of a microbiologic laboratory. It is easier to count mutans streptococci and lactobacilli in saliva, and kits are commercially available for this purpose. These counts, however, do not give site-specific information and are poor predictors for high caries activity in general, although low counts or absence of mutans streptococci arc good predictors of low caries activity.

Dental Plaque

High numbers of mutans streptococci and lactobacilli are probably the consequence of a high sugar intake and the resulting periods of low pH levels in dental plaque. Inversely, it has been shown that restriction of sugar intake reduces the numbers of mutans streptococci and lactobacilli. In one study of individuals complying with a Weight Watchers diet, the numbers of mutans streptococci and lactobacilli were reduced by half. A comparable reduction was found in subjects who reduced their sugar intake frequency from 7.2 to 1.8 times a day. Interestingly, after a period of sugar restriction, the pH response to glucose was reduced in buccal but not in interdental plaque. Apparently, the reductions in numbers of mutans streptococci and lactobacilli are insufficient to reduce the acidogenicity of interdental plaque.

Dental Plaque

The oral flora colonizes on teeth continuously, but it takes up to several days before the dental plaque contains enough acidogenic bacteria to lower plaque pH to the level that causes demineralization. Theoretically, plaque removal every second day would be sufficient. If the dentition is professionally cleaned, an even lower frequency of cleaning has been demonstrated to prevent caries. But we have only to consider the caries prevalence in the prefluoride era to realize that few people are capable of cleaning their teeth to a level adequate to prevent caries.

Teeth

Teeth consist of a calcium phosphate mineral that demineralizes when the environmental pH lowers. As the environmental pH recovers, dissolved calcium and phosphate can reprecipitate on remaining mineral crystals. This process is called remineralization. Remineralization is a slower process than demineralization. When remineralization is given enough time, it can eliminate the damage done during demineralization, but in the absence of this the caries process will progress and a lesion will develop. Dentin is more vulnerable than enamel because of structural differences and impurities in the lattice. For many years, much emphasis was given to the pre-eruptive effect of fluoride improving the quality of the dental hard tissues. However it is now clear that posteruptively used fluoride is more protective against caries.

Diet

Dietary carbohydrates are necessary for the bacteria to produce the acids that initiate demineralization, in general, dietary advice for caries prevention is based in three principles: (1) the drop in pH lasts for approximately 30 minutes; (2) the frequency of intake is more important than the quantity; and (3) the stickiness is an important factor in the cariogenicity of foods, it has become obvious, however, from many epidemiologic studies that where fluoride is used daily sugar consumption and caries prevalence have become independent for many individuals. Even when there was a significant correlation between sugar consumption and caries prevalence, the caries-preventive effect of sugar restriction was small.

Diet

For instance, in Basel, Switzerland, wartime restriction had reduced sugar supply from about 40 to 16 kg/person/year, but the number of caries-free children rose only from approximately 3% to 15%. At that time, the improvement seemed impressive, but it was dwarfed by the effect of nationwide use of fluoride. With this evidence, the role of dietary counseling in caries prevention should be re-examined. This does not negate the value of diet analysis and advice for patients presenting with multiple carious lesions, but the importance if the proper use of fluoride should also be emphasized.

Diet

Information gathered with the reliable pH-telemetry method has revealed that a pH drop induced by eating may last for hours if there is no stimulation of the salivary flow. Even the consumption of an apple can depress the pH for 2 hours or longer. Long pH depressions will be most prevalent m areas where saliva has little or no access, and these are the most caries-prone areas. It is unknown how much additional harm is caused by a second sugar intake during such a period of low pH or how beneficial it is to omit a second sugar intake during that period. These considerations emphasize that at sites where caries lesions develop, advice based on a 30-minute duration of the pH drop is not necessarily effective for caries prevention. In addition, foods believed to be "good“ for teeth may not be better than foods that are supposedly "bad."

Diet

A chocolate and caramel bar might be considered bad because it feels sticky. In reality, the caramel dissolves and leaves the mouth relatively quickly, whereas potato chips, generally considered less harmful, take a longer time to clear the mouth. During this retention, the carbohydrate fraction may be hydrolyzed to simple sugars, providing a substrate for the acidogenic bacteria. All the uncertainties about the determinants of the cariogenicity of foods make it impossible to provide strict dietary guidelines. To snack in moderation, limited to 3 or 4 snacks a day, is the only wise recommendation.

Time

Time affects the caries process in several ways. When caries was commonly considered to be a chronic disease, time was introduced to indicate that the substrate (dietary sugars) must be present for a sufficient length of time to cause demineralization. Now we know that caries is not a chronic disease and that its effects can be arrested or completely repaired should enough time be given for remineralization. Finally it is clear that caries lesions do nor develop overnight, but take time; in fact, it may take years for cavitation to occur. This potentially gives the dentist and the patient ample time for preventive treatment strategies.

Fluoride

Experiments have shown that fluoride protects enamel more effectively when it is present in the ambient solution during acid challenges than when it is incorporated into the enamel lattice. The mechanism by which fluoride inhibits demineralization is by reprecipitation of dissolved calcium and phosphate, thereby preventing these constituents from being leached out of the enamel into the plaque and saliva. Part of the reprecipitation takes place at the surface of the tooth. This narrows the pores in the enamel surface that provide diffusion pathways for the acids produced in the dental plaque to penetrate into the enamel. Acid penetration is thus hampered. In addition, during periods where the ambient pH is above 5.5, fluoride will facilitate remineralization, promoting lesion arrest and repair. A lack of fluoride constitutes a caries risk.

Fluoride

The retention of fluoride in the mouth is site-specific. In plaque and saliva and in dentin samples fixed in dental splints, most fluoride was found on the labial surfaces of maxillary incisors and buccal surfaces in the mandibular molar region after rinsing with a fluoride solution. In addition, it was observed that fluoride from passively dissolving fluoride tablets remained highly concentrated only at the site of tablet dissolution. There was very little or no transport of fluoride between the right and the left sides of the mouth and between the maxillary and mandibular arches. Because of this, localized caries lesions in the mouth may be related to an insufficient spread of fluoride when subjects use fluoride toothpaste. Certainly when patients use fluoride toothpaste they should be encouraged to spit out any excess rather than to rinse vigorously with water.

Saliva

The important role of saliva is clearly demonstrated by the rampant caries that may occur in subjects with compromised salivary flow. These subjects lack the protective qualities of saliva of which the flow rate and buffering capacity may be the most important. Both help to neutralize and clear the acids and carbohydrates from dental plaque. Clearance, however, is not uniform throughout the mouth and may be slowest at the labial aspects of the maxillary incisors and buccal aspects of the mandibular molars. Other sites in the dentition may not be easily accessible to saliva as a result of an individual's anatomy, including interproximal spaces and fissures. Dental plaque in a cavity may also be protected from salivary clearance.

Social and Demographic Factors

The sites that are difficult for saliva to reach may also be difficult to reach with mechanical cleaning devices, such as a toothbrush or dental floss. Plaque and food may adhere for long times in these areas, making these sites more caries prone. Furthermore, this caries risk factor may be easily overlooked in children, whose teeth appear to be clean as judged from the sites that are easily cleaned. These children may even brush their teeth twice daily and have only a moderate number of sugar intake episodes per day. The most feasible way to prevent caries at these sites is by thorough oral hygiene measures and use of a fluoride-containing toothpaste so that plaque is removed and fluoride is applied.

Social and Demographic Factors

Many studies have shown that, at least in the western world, dental caries is more prevalent in the lower socioeconomic categories, in the less affluent areas, and among some ethnic minorities (Table 4-1). Differences related to the socioeconomic status are very clear for the primary dentition and less clear for the permanent dentition, although this pattern may differ in other parts of the world. Studies have shown that for the prediction of caries development, social and demographic factors ,nay be successful in very young children without a long dental history, but for older children, clinical parameters are more predictive. In the elderly population, however, root caries again seems to be more prevalent in people from lower socioeconomic backgrounds.

Caries Prediction

To make the most appropriate treatment decisions, a good estimate of the caries risk is necessary. Indicators of past caries experience are the strongest predictors, and the status of the most recently erupted or exposed surfaces is a strong predictor for the newly emerging surfaces. One very elegant review plots the strongest clinical predictors against age and dentition (Table 4-2). The sensitivity and specificity of the predictors varied from 0.60 to 0.80, indicating that 20% to 40% of the children who developed caries during the study were not identified and that 20% to 40% of the children who were not caries active were, in contrast, predicted to develop caries. In addition, it is important to recognize that none of the studies in the review were designed to predict the progression rate of caries at a specific site. So, even if it could be predicted that an individual would develop caries, the lesion that is going to progress cannot be confidently identified.

Rate of Caries Progression

The decline in caries prevalence has been accompanied by a change in lesion behavior. Caries lesions progress more slowly than they did several decades ago, probably due to increased use of fluoride, which delays lesion progression. It is clear that the progression rate is not the same for each site. Little is known about the progression rate of fissure caries. Longitudinal epidemiologic data from the 1950s, when fluoride was not yet widely used, showed that it took approximately 1 year for an enamel fissure lesion to develop into a dentinal lesion. More recent data from the same geographic area, after the introduction of fluoride toothpaste, showed that 50% of the enamel fissure lesions had progressed to involve dentin within 2 years while 75% had become dentinal lesions after 4 years. Data from Switzerland showed that, for first permanent molars, approximately 10%, 20%, and 45%, respectively, of sound fissures, fissures with a yellowish discoloration, and fissures with a dark discoloration progressed to dentinal caries or tooth restoration in 4 years. These progression rates were slightly lower than those found by the same investigators 10 years earlier.

Rate of Caries Progression

Based on epidemiologic data from the 1950s, the progression rates of proximal caries lesions from initial enamel caries to dentinal caries in the permanent dentition was estimated to be 2 years at age 7 and approximately 4 years at age 12. Data collected after fluoride supplementation became available showed a progression rate of 3 to 4 years for proximal caries lesions to reach the dentin in 12 year olds. Schwartz et al. concluded from data collected in Sweden and the United States that it takes all average of 4 years for caries lesions to progress through the proximal enamel of permanent teeth. The progression rate seemed to be independent of the number of DMFS (decayed, missing, or filled surfaces) of the individuals.

Rate of Caries Progression

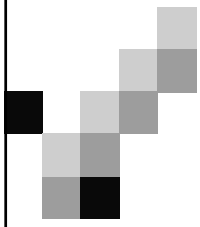
Not all caries lesions progress, however. In one study, over 50% of initial proximal caries lesions had not advanced in a 3-year period in 13-year-old children. The majority of the lesions that progressed were found in the children who had the highest number of lesions at the start of the study, which probably reflects the difference between caries-active and caries-inactive children. Recently, Mejere et al published data on the caries prevalence on the proximal surfaces of the posterior teeth at various ages (Fig 4-3). The caries prevalence was low, with the distal surfaces of the first molars being the most caries prone.

Rate of Caries Progression

Caries on free smooth surfaces seems to progress more slowly than on proximal surfaces or in fissures. Many lesions do not progress into the dentin and even show regression to sound enamel. In one study, dentists were asked at what point they would treat small noncavitated lesions on the buccal surfaces of teeth. Approximately 40% indicated that they would use a preventive rather than an operative strategy. This indicates that many dentists believe that they are well able to judge the severity of buccal lesions and to monitor lesion development.

Rate of Caries Progression

Altogether, the evidence indicates that along with the decline in caries prevalence has come a decline in caries progression rate. Between the initiation of caries and the involvement of dentin in the caries process, there is ample time for a preventive management strategy. This implies that the early lesion should be detected so that preventive treatment can arrest its progress and bring about remineralization. If this strategy is successful, operative intervention will not be required.



Detection and Diagnosis

Detection and Diagnosis

When a dentist identifies a carious lesion, it is a change in mineral content that is detected. The dentist must also determine whether a lesion is active or arrested before a logical management plan can be proposed; the dynamics of the caries process must be recognized.

Detection

Teeth must be clean for the clinical detection of carious lesions. Otherwise, reliable detection may be obstructed by the presence of plaque (Figs 4-4a and 4-4b). The teeth are cleaned and an air/water syringe used so that the tooth surface may be dried. This drying has two functions: the first is to remove saliva, which can obscure a lesion; the second is to dry a white spot lesion. Removing water from the porous tissue in this way enables the dentist to gauge how far through the enamel a lesion has progressed. A white spot lesion visible on a wet tooth surface indicates that demineralization is over halfway through the enamel, possibly extending into dentin. A white spot lesion that becomes visible only after thorough airdrying will be less than halfway through enamel.

Detection

The dentist also requires bite-wing radiographs to assist in the detection of proximal caries lesions, occlusal caries lesions, and recurrent caries. The radiographs should be taken using a film holder and beam aiming device to take the guesswork out of tube alignment and allow comparable views to be taken on subsequent occasions. Because lesions confined to enamel on radiographs should be managed by preventive treatment, monitoring them is important. Magnification is a great adjunct to caries detection.

Pit and Fissure Lesions

Detection of caries in fissures and pits is most often done by visual inspection. Good lighting and dry, clean teeth are prerequisites. It appears that any sign of visible cavitation in the occlusal surface corresponds to progression of the lesion into the dentin. Interpretation of the occlusal surface that appears caries free can be difficult, but it is possible if all plaque is removed and the teeth are dried, as shown by Ekstrand et al. When occlusal surface caries was recorded visually using a caries score ranking system (Table 4-3), a high correlation with the histologic depth of the lesions into enamel and dentin was found (Table 4-4).

Pit and Fissure Lesions

A clear ranked caries scoring system is useful for subsequent assessment and monitoring. Careful examination of bite-wing radiographs is also important, although enamel lesions will not be visible. Caries in dentin, however, can usually be detected, and such lesions are often large (Fig 4-5). Bite wing radiographs can be considered to provide a safety net function for large occlusal lesions. For assessment and monitoring, a ranked scoring system can be used (Table 4-5).

Pit and Fissure Lesions

Tactile examination of fissures with a dental explorer has been advocated for many decades (even centuries) as an important method to detect caries, but research has shown this to be an unwise practice. The method is inaccurate and, worse, the explorer can damage a white spot lesion by breaking through the relatively intact surface zone (Fig 4-6). Vigorous use of a sharp explorer can cause a cavity, which will subsequently trap dental plaque and encourage lesion progression. Detection of fissure caries lesions should rely on sharp eyes, not sharp explorers.

Lesions Involving Proximal Surfaces

When there is contact between proximal surfaces, the radiograph is the most accurate method for detecting demineralization. In the premolar and molar regions, lesion progression or arrest can be monitored, provided that appropriate film holders and beam-aiming devices have been used to ensure that subsequent bitewing radiographs are taken at approximately the same angulation, The radiograph should be examined carefully to determine whether carious lesions are present in the outer enamel, at the dentinoenamel junction, in the outer half of dentin, or in the inner half of dentin (Figs 4-7a and 4-7b).

Lesions Involving Proximal Surfaces

Fiberoptic transillumination techniques have proven useful. With these techniques, a fine light, coned down to a 0.5-mm diameter, is transmitted through a contact point. Iesions appear as a dark shadow. It is difficult, however, to discriminate between demineralization extending just into enamel and that progressing further into dentin, especially in the posterior areas. For detection of proximal lesions m anterior teeth, however, the fiberoptic transillumination technique is particularly appropriate and convenient.

Lesions Involving Proximal Surfaces

Finally, use of an orthodontic separator has been advocated in some cases to allow the dentist to see more clearly and to gently feel for a break in the enamel surface.

Lesions Involving Proximal Surfaces

Lesions in Smooth, Free Surfaces Lesions in smooth, free surfaces, whether in the enamel of the crown or the dentin of the root, can be detected easily with visual inspection. The surface to be examined must be cleaned, dried, and well illuminated. Again, drying with an air syringe can be used to assess the depth of penetration of a white spot lesion through the enamel.

New Detection Devices

The development of several new devices and detection methods is promising. Electronic caries monitors are based on the principle that porous carious lesions have lower conductive values than intact tooth structures. Various optical methods, including several laser systems, are promising, as are the new ultrasonic devices. Experimental results, however; show that further development and research are required before application in general practice can be recommended.

Diagnosis

What is the difference between lesion detection and diagnosis?

Caries is a ubiquitous, natural process that does not have to progress. Detecting mineral loss resulting from the carious process is only the first step. If this information is to be useful, whether the detected lesion is arrested or active must be determined. If the lesion is arrested, no treatment is required unless for esthetic or functional reasons; if the lesion is active, preventive treatment, which may include operative dentistry, is needed to arrest lesion progression. Thus diagnosis adds the dimension of lesion activity to detection.

Assessing Caries Activity

There are some features of individual lesions that indicate whether a lesion is active or arrested. Some of these features will be obvious the first time a dentist and patient meet. However, most patients see their dentist at regular intervals. Thus the initial diagnosis can and should be refined at recall, and these visits provide the opportunity to assess the effects of preventive treatment. Has a lesion, previously diagnosed as active, apparently arrested. Table 4-6 lists some of the parameters relevant in the assessment of caries activity.

Assessing Caries Activity

Following are discussions of the individual sites where caries may occur with definitions of the features of active and arrested lesions. Difficulties in making this distinction are highlighted.

Occlusal lesions

The visual and radiographic features of occlusal caries have been presented (see Tables 4-3 and 4-5). The following features indicate lesion activity:

* White spot lesions that have a matte or visibly frosted surface or are plaque-covered after drying or application of a disclosing solution.
* Cavitated lesions, including microcavities as well as cavities exposing dentin (Fig 4-8)
* Lesions visible in dentin on bite-wing radiographs.

The following feature indicates that the lesion may be arrested:

* White or brown spot lesions with a shiny surface (Fig 4-9).

Proximal lesions

Diagnosis of lesion activity is more difficult when the adjacent tooth precludes a direct visual assessment. (The radiographic features are presented in Chapter 2 and in preceding paragraphs.) The presence or absence of a cavity is relevant to lesion activity, but unfortunately this cannot be judged from the radiograph. The reason a cavity is important is that for an active carious lesion to be arrested, plaque must be regularly removed from it. But on a proximal surface, there is no access for the toothbrush, and even the most fastidious of flossers will only skate over the surface.

Proximal lesions

The following tend to indicate lesion activity:

~ A patient with proximal lesions on the radiograph who is judged to be at high caries risk (described later in this chapter)

~ A proximal lesion present radiographically and persistent gingival inflammation despite the patient's attempts to remove plaque with dental floss.

~ A lesion not present at previous examination. The following features indicate that the lesion may be arrested:

~ Successive, reproducible, bite-wing radiographs showing no lesion progression

~ A patient who is now judged to be at low risk for caries following preventive treatment

Smooth-surface lesions

These are probably the most straightforward lesions for assessing activity because they are the most visible. Of all lesions, these are the ones most likely to be arrested by preventive treatment alone. Indeed, they are a barometer that a patient can and should watch in the quest for dental health.

Smooth-surface lesions

The following indicate lesion activity:

White spot lesions close to the gingival margin that have a matte or visibly frosted surface; these are often plaque-covered (Fig 4-10). Cavitated, plaque-covered lesions with or without exposed dentin; if dentin is exposed and soft, the dentin is heavily infected and the lesion is active (Figs 4-11a and 4-11b).

The following indicate that the lesion is arrested:

Shiny white or brown lesions, often well exposed due to recession; the lesions are not plaque-covered (Fig 4-12). Cavitated lesions, often dark brown, with hard dentin at their bases; the lesions are not plaque covered and are often remote from the gingival margin (Fig 4-13).

Smooth-surface lesions

Root caries. Active lesions are:

~ Close to the gingival margin and plaque-covered

~ Soft or leathery in consistency

Arrested lesions are:

~ Often some distance from the gingival margin and not covered with plaque (Fig 4-14)

~ As hard as the surrounding healthy root surface. Color is unreliable in differentiating active from inactive lesions. While arrested lesions may be dark, so may the soft dentin in some active lesions. The research community has yet to fully explain why demineralized dentin is brown.

Recurrent caries

Caries at the margin of or beneath a restoration is called recurrent caries, and its diagnosis on various tooth surfaces is as described previously. The bite-wing radiograph is very important in the diagnosis of recurrent caries since lesions often form cervical to an existing proximal restoration, in the area of plaque stagnation. Lesions that are obviously in dentin as seen radiographically tend to be cavitated and active. However, research has shown that the following are not reliable indicators of active caries beneath a restoration: ditching and staining around an amalgam restoration, staining around a tooth colored restoration.

Assessment of Caries Risk

In addition to differentiating active from inactive lesions, determining the overall caries risk for the patient is an important factor. If a patient presents with many cavitated lesions and a dentist skillfully restores the teeth, is the patient still at risk of caries. The answer is "yes" unless the biologic environment that caused the caries to occur has been changed. Preventive treatment is needed, in addition to operative care, to help the patient to remove plaque more effectively, to modify the diet if appropriate, to use fluoride to delay lesion progression, and to attempt to stimulate saliva if the mouth is dry. The role of operative procedures. The caries control is to facilitate plaque control, but restorations alone cannot be relied on to change the patient's caries risk status, particularly if tile risk status is high.

Assessment of Caries Risk

Patients should be made aware of their caries risk status to encourage them to become involved in their own preventive care, to keep appropriate recall appointments, and perhaps to help them budget for dental costs. It is also important for patients to realize that caries risk status can change and their dentist can detect this change. Examples of a change in risk status may be the onset of a dry mouth or a change in ability to remove plaque.

Assessment of Caries Risk

Assessment of caries risk is an important part of contemporary dental practice, and it is something that general practitioners do rather well. Indeed, research has shown that a dentist's best guess of a patient's caries risk may be as accurate as any combination of more objective factors. These factors include:

~ Clinical evidence
~ Plaque control
~ Use of fluoride
~ Dietary habits
~ Saliva
~ Medical history
~ Social history

Assessment of Caries Risk

An experienced practitioner will be able to assess caries risk in less time than it takes the reader to read these descriptions. Risk assessment is an intellectual process demanding both clinical skill and experience. Dentists should define the caries risk status of each patient, and, whether the risk is high or low, they should identify the reasons. Interestingly, it can be more difficult to explain low risk than high risk. However, it is with the high-risk patient that the definition becomes critical to patient management. It is important to determine whether or not the risk factors can be modified and if so, how this can best be done.

Clinical Evidence

Clinical evidence has been shown to be the best predictor of caries risk. The findings of many initial lesions or many restorations requiring frequent replacement provide evidence of high risk for caries. There may also be a history of teeth being extracted because "they were too carious to be restored." Clinical and radiographic examinations, described earlier in this section, are very important, if the dentist can review earlier radiographs, perhaps taken over years, the caries stares of the patient may be graphically displayed.

Clinical Evidence

It should also be remembered that adding a dental appliance to the environment, such as an orthodontic appliance or a partial denture? may tip the balance toward high risk. Because appliances favor plaque retention, they should be avoided in high-risk patients when possible.

Plaque Control

Dental plaque is the primary risk factor for dental caries. Not all patients with poor plaque control will inevitably develop caries, bur oral hygiene is the bedrock of a caries control program in a high-risk patient. If for any reason plaque control becomes difficult, perhaps because of age or long-term illness, caries risk can change.

Use of Fluoride

Fluoride delays the progression of the carious process, and patients living where the water is fluoridated will benefit, particularly in areas of social deprivation. Today most patients use a toothpaste containing fluoride, but it is wise to ascertain this in those with multiple, active lesions.

Dietary Habits

High sugar intake is considered an important factor in caries risk, but not all patients with high sugar intake will develop caries. It is, however, unusual to find a patient with multiple active carious lesions who does not have a high sugar intake. It is also important to remember that dietary habits can change. Changes in lifestyle such as unemployment, retirement, or be revetment can have profound implications, and a vigilant dentist will take such changes into consideration.

Saliva

A dry month is one of the most important factors predisposing to high caries risk. The four most common causes are:

* Many medications, such as antidepressants, antipsychotics, tranquilizers, antihypertensives, and diuretics, can cause dry month.

* Patients with rheumatoid arthritis may also have Sjogren's syndrome, which affects the salivary and lacrimal glands, leading to a dry mouth and dry eyes.

* People with eating disorders may suffer from hyposalivation, which, combined with a poor diet, can lead to extensive caries.

* Patients who have received radiation therapy in the region of the salivary glands for a head and neck malignancy will often suffer from xerostomia.

Saliva

Numerous research studies have also shown that salivary counts of mutans streptococci and lactobacilli help predict caries risk.III This huge volume of work appears to show that in individual patients, low counts often predict low risk well, but the opposite is not necessarily true. The routine use of salivary counts for prediction of risk status is, therefore, not recommended.

Medical History

Medically compromised and handicapped people may be at high risk for developing caries. For these patients, oral hygiene may be difficult, and long-term use of medicines can be a problem if the medicines are sugar-based or cause reduced salivary flow. The most important caries risk factor in a medical history is the complaint of dry mouth, discussed previously. It is important to realize that the medical history is one factor in a caries risk assessment that can change. A vigilant dentist will detect such changes and help the patient with the potential dental consequences.

Social History

Many studies have shown that social deprivation, can be an indicator of caries risk. Other diseases, such as coronary heart disease and some cancers, are also prevalent in socially deprived people. The dentist may notice high caries in siblings, and the patient or parent may possess little knowledge of dental disease. Concern about dental health may be low and dental visits irregular.

Identifying Relevant Risk Factors

While it is relatively easy for an experienced dentist to classify patients into a high- or low-risk category, determining the cause of the risk may take longer. However, this is time well spent and an essential part of diagnosis, An appropriate plan of action cannot be formulated until the factors that require modification have been defined. Identifying the reasons that the patient is at high risk is also relevant to prognosis. Can the patient modify the risk factor? Some causes of dry mouth are impossible to alter and the patient may always be at high risk.

Another individual may be able to change his or her risk status by modifying plaque control and/or diet, but these changes demand behavioral modification. The patient must take responsibility for the problem rather than transferring responsibility to the dentist. Unless the high-risk patient accepts responsibility for modifying behavior and improving his or her dental health, no restorative services, no matter how well executed, will prevent the caries recurrence.

Treatment Strategy

Treatment Strategy

Traditionally, radiographic evidence of demineralization in enamel or to the dentmoenamel junction led to the immediate decision to place a restoration. Such management is still an accepted part of some state board examinations. However, contemporary research has shown that this is not the optimal approach. Radiographs may reveal demineralization, but the caries activity of the lesion must be assessed. If the lesion is arrested, it requires no treatment. The management of an active lesion should be directed to redressing the imbalance of demineralization and remineralization. This management may arrest the lesion so that a restoration is never required.

Treatment Strategy

Caries is often presented as a one-way process; sugar in the presence of plaque causes demineralization that presents as a white dull lesion. As the process progresses, a hole or cavity results (Fig 4-15). In fact, caries is a dynamic process in which periods of demineralization and remineralization alternate depending on the oral environment. It may be possible to cure or arrest an early lesion on a free smooth surface (Fig 4-16). On a smooth surface, even cavitated lesions can be arrested because plaque may be removed with a toothbrush.

Treatment Strategy

Caries is caused by a multifactorial process, and its management should reflect this. The general approach to active caries should be preventive treatment including plaque control, use of fluoride, and dietary modification. Restoration forms only one part of a strategy to facilitate plaque control.

Preventive Management Strategies

The most plausible explanation for the decline of caries prevalence is the steady improvement in oral hygiene, which results in regular (at least partial) removal of dental plaque, combined with a regular daily administration of fluoride, provided via toothpaste. A recently published analysis of data derived from a sample of 1,450 preschool children studied in the British National Diet and Nutrition Survey confirmed the significant caries-inhibiting effect of toothbrushing with a fluoride dentifrice twice daily. On a population basis, sugar-containing foods and drinks were not associated with caries experience, unless children brushed once a day or less.

Preventive Management Strategies

Thus, the cornerstone of any preventive strategy for the management of caries is oral self-care: twice daily careful cleaning of the teeth with a toothbrush and an effective fluoride toothpaste. Additionally, dental floss should be used, but patients should be instructed carefully and the frequency should be individually recommended. In areas where the water is fluoridated to optimal levels, twice daily careful cleaning of the teeth is a safe and effective preventive treatment and caries management strategy.

Preventive Management Strategies

If caries or caries progression is not prevented, the reasons should be carefully examined (Fig 4-17). A first step in this procedure is to carefully assess the quality of the oral hygiene. If hygiene is adequate, it is appropriate to evaluate whether additional risk factors such as multiple intake episodes of sugar-containing foods and drinks are present. If so, these risks must be reduced as much as possible. In the meantime, the patient can be helped with professionally applied preventive measures such as topical application of concentrated fluoride solutions, gels, or varnishes, or chlorhexidine gels or varnishes. Salivary flow can be stimulated by daily use of sugar-free chewing gum. When no additional risks can be identified, the fluoride supply must be intensified, perhaps by adding a third daily fluoride application in the form of additional brushing, mouthwash, or tablet.

Preventive Management Strategies

If the daily oral hygiene procedures are inadequate, an attempt should be made to determine whether the problem is due to an inability to use a toothbrush or whether the patient simply is noncompliant. The dentist should apply disclosing solution to the teeth and watch as the patient demonstrates the oral hygiene procedures. If he or she is not able to remove the plaque, the patient should be taught alternative methods. Sometimes a patient can be helped by professionally applied preventive measures. If a patient is able to remove plaque but is not motivated to do so, the dentist must try to determine the reasons. The patient may not be convinced of the necessity for thorough plaque removal. This puts the dentist in the realm of behavior modification, a subject not in the scope of this textbook but an important part of dental practice.

Professionally Applied Preventive Measures

Professionally applied topical fluorides in solutions, gels, or varnishes have been shown to be effective in many clinical trials. The effectiveness seems not to depend on the method of application, the use of additional fluoride supplements, or baseline caries prevalence. A recent meta-analysis revealed a 22% to 26% overall caries-inhibiting effect for fluoride gel treatments. Chlorhexidine, as a 1% gel or a 40% varnish, has also been successfully applied to prevent caries. Applications of the chlorhexidine products are more laborious than fluoride applications and must be performed every 3 to 4 months. In addition, they have been shown to reduce caries only ill those who harbor l0t' mutans streptococci or more per milliliter of saliva. To select these patients, the number of mutans streptococci should be quantified in saliva.

Professionally Applied Preventive Measures

With the decline in caries prevalence, the professionally applied preventive treatments do not seem appropriate on a population basis. In a population with, for example, a mean caries incidence of 0.25 DMFS/year, a preventive treatment with 22% effect would theoretically save 0.055 DMFS/year/individual. In the total population, 36 treatments would be needed to prevent 1 DMFS/year. With a low caries activity, the cost-effectiveness ratio is unfavorable. Based on cost-effectiveness calculations, an individual can decide whether he or she is willing to pay for professionally applied treatments to prevent tooth decay.

Treatment of the Lesion or Cavity

Carious lesions are detected at a relatively late point of development. This may be due to difficulties in detecting the early lesion or it may be because tile patient did not visit the dentist early in the lesion process. Although this may suggest the value of a rigorous, invasive approach, it is preferable, because of the iatrogenic damage that may occur during preparation, to select a treatment option that is as conservative as possible. The treatment should be based on the interpretation of the activity of the lesion and on future caries risk. Figure 4-18 demonstrates a decision-making tree for occlusal fissure lesions with different features leading to different treatment options dependent on lesion activity and risk assessment.

Treatment of the Lesion or Cavity

Although lesions that are cavitated are treated traditionally by preparation and restoration, a preventive treatment approach is often successful, especially when the lesion is in a free smooth surface. When a lesion is present in an occlusal or proximal surface, it will often be difficult to arrest lesion progression because of the difficulty of removing plaque. However, when lesions are in buccal or lingual surfaces, or in the roots of teeth, it is often possible for the patient to tip the balance of demineralization and remineralization in the right direction and stop further progression of the lesion.

Causal, Noninvasive, or Preventive Treatment

Where individual lesions or cavities are concerned, the treatment options are to restore or not to restore. If the decision is made not to restore, the question arises, can the lesion or cavity be cured, or at least prevented from further extension; in other words, can it be arrested? When considering caries, factors such as plaque, fluoride, and diet are of paramount importance. Management of the lesion should be directed such that optimal plaque removal, sufficient fluoride application, and a healthy diet prevent further deterioration. It is still relevant to ask what effects preventive treatment has on initial demineralized lesions and on cavities: Can they be cured (healed) or merely arrested?

Initial Lesions

Von der Fehr et al and Koch have shown that normal individuals can be turned into individuals with high caries risk. Within a short period of time, numerous initial carious lesions can develop when oral hygiene is withdrawn and a sugar-rich diet is offered. However, when effective oral hygiene and application of topical fluoride are instituted, and a normal, less sugar-rich diet is consumed, reversal of the situation seems possible; after a period of time, the initial lesions are no longer visible. But are they healed or controlled? Thylstrup et al demonstrated that in the very early lesion, only the external microsurface is dissolved by plaque. When the plaque is removed mechanically at this stage, the eroded area will change from the chalky white appearance of the earlier active lesion into a hard and shiny surface. It has been suggested that this phenomenon is caused by wear and polishing and not by recovery of the carious surface.

Initial Lesions

Further progression of the lesion leads to deeper surface and subsurface dissolution. Intervening in the process with plaque removal, fluoride application, and a better diet leads again to wear and a polished surface, and a slowly rematerializing subsurface lesion, Although these lesions decrease in depth and width in course of time, they may remain visible as shiny white lesions, commonly seen on facial surfaces. In this case, the lesion cannot be considered completely recovered, but it can be concluded that the caries process has ceased. These arrested lesions may be seen throughout life as whitish or brownish "scar tissue" (Figs 4-19a and 4-19b). Research has shown that these areas are more resistant to a subsequent caries attack than sound enamel.

Initial Lesions

The average speed of progression of carious lesions on different surfaces has been determined. On proximal and free smooth areas, caries proceeds slowly. It is thus reasonable to postpone restorative intervention. A procedure whereby the patient is examined regularly ("watchful waiting") creates the opportunity for arrest and remineralization. "Watchful waiting" implies that nothing is done, but in fact it is based on the intellectual decision not to restore be cause of knowledge of the caries process. The dentist is performing active preventive treatment by helping the patient to improve oral hygiene, by applying fluoride, and by encouraging the patient to modify his or her diet. These measures should always be carried out when active noncavitated lesions exist. But what should be done when further progression has led to a cavity?

Cavitated Lesions

Several authors have shown that when an occlusal lesion has cavitated, the dentin is always involved in the process, Moreover, these lesions, mostly detectable on radiographs, contain many microorganisms and are therefore considered active, It is not difficult to imagine that measures directed to a thorough removal of plaque are ineffective on the occlusal surface because the bristles of the toothbrush cannot get into the undermined cavity. Proximal cavitations are also difficult to reach. Dental floss will skim the surface but will not have access to the cavitated area.

Cavitated Lesions

However, where there are cavitated areas on free smooth surfaces, the situation is different. Those areas are easily reached by the toothbrush but may be difficult to clean due to undermining of the enamel. Removal of the overhanging enamel margins must be considered to aid in keeping the whole area free of plaque. Cavities in these surfaces, cleaned twice daily with a fluoride toothpaste, can be arrested and converted into leathery or hard lesions (see Figs 4-13 and 4-14). When the activity of highly infected caries lesions is decreased and finally arrested, the carious layers contain few bacteria that can be cultivated.

Cavitated Lesions

Though occlusal or proximal caries lesions cannot be approached by preventive measures alone, in primary molars this method can be successful. Therefore, undermined enamel margins should be eliminated, so that when plaque is removed, fluoride can be applied easily to the carious dentin. Under ideal conditions, carious dentitions can be managed so that caries is arrested and demineralization and remineralization are in equilibrium (Figs 4-20a and 4-20b).

Sealants

Fissures are more susceptible to caries than smooth surfaces because fissure anatomy favors plaque maturation and retention. When active fissure caries has been diagnosed or if a high risk has been established and fissures have susceptible morphologic characteristics, sealants may be indicated (see Fig 4-18). After acid etching, a lightly filled resin fissure sealant or a flowable resin composite is used to penetrate the tissues and prevent plaque accumulation. This is especially important during the period of tooth eruption, although the application of sealants in suspect fissures is also advisable in older patients with high caries risk. Advantages of fissure sealants are that no irreversible interventions are necessary, active dentin lesions inadvertently covered by the resin do not progress further, and the possible development of new lesions in other sites of the fissure is prevented. Sealants have been used successfully for many years.

Sealants

Concern has been expressed about placement of sealants over undiagnosed dentin caries lesions. However, there is ample evidence that caries does not progress as long as the fissure remains sealed. Sealed, radiographically evident caries has been shown in one study nor to progress over a 10-year period. Also, sealed restorations placed directly over frankly cavitated lesions arrested the progress of these lesions. Sealing of restorations, therefore, appears to be very effective in conserving sound tooth structure, protecting the margins of restorations, and preventing recurrent caries.

Symptomatic (Invasive or Restorative) Treatment

It is necessary to have well-defined criteria for the decision to restore due to caries. The most important reason for placing a restoration is to aid plaque control. Elderton and Mjor formulated the following indications for restorative treatment:

~ The tooth is sensitive to hot, cold, sweetness, etc.

~ Occlusal and proximal lesions extend into dentin.

~ The pulp is endangered.

~ Previous attempts to arrest the lesion have failed and there is evidence that the lesion is progressing (such evidence usually requires an observation period of months or years).

~ The patient's ability to provide effective home care is impaired.

~ Drifting is likely to occur through loss of proximal contact.

~ Esthetic reasons.

Symptomatic (Invasive or Restorative) Treatment

Treatment will be directed in such a way that infected dental tissue is removed and the remaining cavity is adapted so that the restorative material can be optimally placed. The particular preparation methods and restorative procedures are discussed in the following chapters.

Symptomatic (Invasive or Restorative) Treatment

Most dentists enjoy the technical, esthetic, and intellectual challenges of restorative dentistry. However, before invasive procedures are initiated, noninvasive options must be explored and preventive measures taken. Restorative dentistry is one part of preventive treatment. Above all, it must be remembered that caries is a dynamic process and the diagnosis requires the determination of caries activity and risk assessment.