REVIEW ARTICLE

Minimal invasive dentistry

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Abstract

A surgical approach to the elimination of a carious lesion was developed a century ago this approach was necessary at that time because there was no valid alternative. The process of caries and the significance of fluoride ion were not known, so the microbiology of the oral flora and the potential for remineralization and healing of tooth structure was not considered. This approach required maximal intervention into the crown of the tooth. Destruction of sound tooth structure was necessary to ensure complete removal of a diseased portion and to obtain retention for the restoration.

Keywords: Cavity, dental caries, dental materials

Introduction

Minimal intervention is a new concept introduced by Mount and Hume in 1997, and they suggested to the dental profession that it was time for changes in the principles of operative dentistry. Minimal intervention in relation to dental caries covers a vast area of diagnosis, risk assessment, prevention, and control.[1]

Concept of minimal intervention dentistry (MID) has evolved as a consequence of increased understanding of the carious process in the prevention of its occurrence, inhibition of its progression and the development of newer adhesive restorative materials. Now the non-cavitated and demineralized enamel and dentin, which was treated by surgical method along with "extension for prevention" as proposed by Black is no longer exist.[2]

Minimal intervention approach starts with diagnosis and risk assessment of the disease in order to allow for proper treatment decision. Different techniques for management of initial carious lesion include non-invasive management and operative care. Advancements in management of caries has started a trend toward the conservation of tooth structure and also bonding techniques which provide an alternative to mechanical retention.

The main goal of minimal intervention is to increase the life of the teeth, which was restored with less intervention. Now the concept is "prevention of extension" rather than "extension for prevention."

Diagnostic AIDS in Caries Identification[3]

Some decades ago, visual diagnosis (light and mirror) and probing, supplemented by bitewing radiographs, were the only tools available for clinical diagnosis of caries. However, the last 10 years have seen a considerable increase in the assortment of diagnostic tools based on new technology.

The ideal method or tool for diagnosis of carious lesions should be non-invasive and provide simple, reliable, valid, sensitive, specific and robust measurements of lesion size and activity and be based on biologic processes directly related to the carious process. It should also be affordable, acceptable to dentists and patients and allow early implementations in both clinical practice and research settings. Its use should promote informed and appropriate preventive treatment decisions, enhancing long-term oral health. Unfortunately, there is at present no single, all embracing method that fulfills these requirements. Therefore, the dentists and researchers have to select the combination of methods that is most appropriate to the particular diagnostic task at hand.

The following methods are now available for the identification of demineralized areas of tooth structure and presence of cavitation.[4]

1. Visual method
2. Visual – Tactile method

3. Radiographic method
   a. Conventional radiographs
   b. Xeroradiographs
   c. Digital radiograph
   d. Computer aided radiograph
   e. Subtraction radiograph.
4. Laser fluorescence method
5. Fiber-optic transillumination method
6. Electrical conductive method
7. Ultra violet (UV) illumination method
8. Ultra sonic imaging
9. Endoscope/videoscope
10. Dye penetration method.

Caries Prevention

Primary goal of caries prevention program should be to reduce the numbers of cariogenic bacteria. Prevention should start with a consideration of overall resistance of the patient to infection by the cariogenic bacteria. Although the general health of the patient, fluoride exposure, history and function of the immune system and salivary glands have a significant impact on risk, the patient may have little control over these factors.[5]

On the other hand, patient usually is capable of controlling other factors such as diet, oral hygiene, use of antimicrobial agents and dental care.

Preventive treatment methods are designed to limit tooth demineralization caused by cariogenic bacteria, thereby preventing cavitated lesions. These include;

1. Limiting pathogen growth and metabolism
2. Increasing the resistance of the tooth surface to demineralization.

Caries control methods are operative procedures used both to stop the advancement of the individual lesion and to prevent the spread of pathogenic bacteria to the other tooth surface and in this sense, these are preventive procedures. These operative procedures remove irreversibly damaged tooth structure and the associated pathogenic bacteria in the site.

Principles of Minimal Intervention

Minimal intervention operative dentistry is dependent on following factors:[6]

1. Deminerlization – Remineralization cycle
2. Adhesion in restorative dentistry
3. Biomimetic restorative material.

Minimally invasive (MI) preparation techniques

Today, the adhesive restorative materials in conjunction with increased knowledge on the pathology of caries and effective preventive methods allow for MI techniques. Alternative methods for caries removal have been developed for use with hand instruments, such as atraumatic restorative and chemomechanical techniques. The desire for preparation of small dimensions and microcavities has stimulated new approaches for cavity design and tooth cutting concepts, such as oscillating, kinetic, and hydrokinetic cavity preparation systems. The preparation technology described shows a wide variety of clinical application, but each of the techniques has significant potential and is currently used in general practice.[7]

MI preparation techniques	
Mechanical	
Atraumatic restorative treatment	ART
Rotary	High/low speed bur
Sonic oscillation	SONICSYS micro
Chemomechanical	Carisolv
Kinetic	Air abrasion
Hydrokinetic	Laser (CO_2, Er: YAG, Nd: YAG, etc.)
Ozone technology	O_3

MI: Minimally invasive

Fissure sealants

The use of fissure sealants in occlusal pits and fissures is an important MID clinical procedure for prevention of occlusal caries. As discussed previously, the initiation of caries occurs in the stagnant biofilm, which accumulates at the opening of a fissure. Many systematic reviews of clinical trials confirm the effectiveness of resin sealants in occlusal caries prevention, particularly for permanent molar teeth.

Traditionally, resin-based sealants have been the material of choice, with higher retention rates than glass ionomer cement (GIC) fissure sealants. However, when the absence of occlusal caries on permanent teeth protected by either type of sealant material is compared, GIC appears to be as effective as resin for preventing dental caries in pits and fissures. A key aspect of caries prevention by fissure sealants is the need for monitoring and long-term maintenance of sealant.

Mechanical Techniques

Atraumatic restorative treatment (ART)[8]

ART consists of an elementary technique of caries removal using hand instruments only and also combined with the use of modern restorative material with adhesive characteristics. This approach was pioneered in Tanzania in the mid 1980's as a part of community based primary oral health program by the University of Dares Salaam.

Currently GIC that leach fluorides and minimize the onset of secondary caries are used. The often cited disadvantages of GIC namely low wear resistance and strength are minimized because the cavity preparations of ART technique usually result in relatively small restorations. In addition, new GIC with improved wear resistance and strength are being developed specifically for ART technique.

Sonic oscillation (SONO-Abrasion)[9]

"A recent development from the original ultrasonics is the use of high frequency, sonic air-scalers with modified abrasive tips a technique known as SONO-ABRASION." The tips describe an elliptical motion with a transverse distance of between 0.08 and 0.15 mm and a longitudinal movement of between 0.055 and 0.135 mm. They are diamond coated on one side using 40 μm grit diamond and are cooled using water irrigant at a flow rate between 20 and 30 ml/min. The operational air pressure for cavity finishing should be around 3.5 bar.

Chemomechanical caries removal (CMCR)[10]

CMCR involves softening of dentin by the application of chemical agent, which can then be excavated gently using the spoon excavator. When aminoacids with NaOCl, is mixed it results in N-Monochloroaminoacids formation which selectively degrade the demineralized collagen in carious dentine. The time taken for this is about 10-15 min. It is well suited to the treatment of deciduous teeth, dental phobics, and medically compromised patients. Composite resin or GIC are the best materials for restoring the tooth.

Kinetic - air abrasion technique[11]

This system involves the use of alumina particles entering in high velocity stream of the air to remove tooth structure. This method is suited for restorations with currently bonded resin materials and tooth conservation and improves the longevity of restoration. The father of the concept of the air abrasive microdentistry is an American Dentist, Dr. J. Tim Rainey, from Refugio, Texas, USA.

Hydrokinetic technique – Lasers[12]

Lasers are devices that produce beams of coherent and very high intensity light. A large number of current and potential uses of lasers in dentistry have been identified that involve the treatment of soft tissues and modification of hard tooth structures. However, early studies found that the ruby laser produced significant heat that caused damage to a pulp. Since these early beginnings, the field of lasers has developed considerably, and many types of lasers are available to cut dental hard tissues. The efficacy of the lasers will depend on numerous factors including the wave length characteristics, pulse energy, repetition rate and the optical properties of the incident tissue.

Lasers that are currently being investigated for more selective hard tissue ablation include:

- Erbium: Yttrium – aluminum-garnet (YAG) and neodymium: YAG – Mid infrared (IR) to IR emission
- CO_2 laser – IR emission
- Excimer lasers (ArF [Argon: Freon] and XeCl [Xenon: Chlorine]) UV emission
- Holmium lasers
- Dye enhanced laser ablation – exogenous dye, indocyanine green in conjunction with a diode laser.

Ozone technology (O_3)[13]

Ozone (O_3) is an energized form of oxygen. Ozone therapy has been extensively used in the medical professions since more than a century. It is no longer a discussion point reserved for the environmentalists only. Currently, a new treatment modality based on ozone is being introduced as an alternative to local anesthesia, drilling and filling for the management of dental caries. Ozone is one of the nature's most powerful oxidant, which accounts for its ability to kill bacteria, spores, and viruses. Ozone therapy is based on the premise that the primary carious lesions when exposed to ozone become sterile and re-mineralize after some time. Thus, it presents a radically different approach to the traditional "ampulation" approach to remove the acidophilic microorganisms in dental caries.

Cavity Designs for Minimal Intervention

Cavity design principles

1. Gaining access to the body of the lesion without being destructive
2. Removal of tooth structure that is infected and incapable of regeneration
3. Avoiding the exposure of dentine unaffected by the caries process
4. Retaining and reinforcing sound, but undermined enamel
5. Reducing perimeter of the restoration
6. Keeping the margins of the restoration away from the gingiva
7. Reducing occlusal stress on the final restoration.

Designs of cavity preparations [Figure 1][14]

Specific designs for approximal lesions:

I. Tunnel preparation
II. Microchip cavity preparation
III. Minibox cavity preparation
IV. Full box cavity preparation.

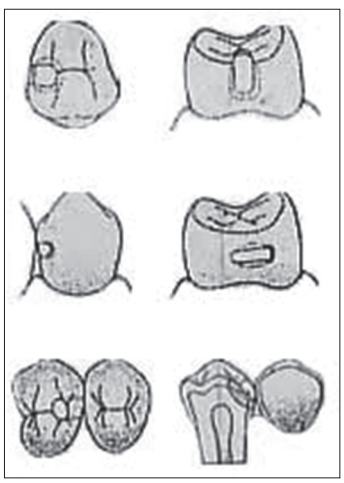

Figure 1: Designs of cavity preparations

Rotary – high/low speed

Though the rotary bur is in universal use, there are still problems that need to be overcome.

Five factors are potentially responsible for discomfort and pain associated with cavity preparation.

1. The sensitivity of vital dentine
2. Pressure on the tooth (i.e. Mechanical stimulation)
3. High pitched noise of air turbine handpiece and
4. Development of high temperature at cutting surface (i.e. thermal stimulation).

Several studies have showed that temperatures at the cutting surface of burs even with water spray lubrication, cause some damage to the underlying pulp.

The rotating bur easily cuts through carious dentin to eventually open up healthy tubules deeper in the tissue and in conjunction with water stimulation of odontoblastic processes that will result in pain associated with cavity preparation using this technique.

Conclusion

It is apparent that it is time for a change in operative dentistry. It is not possible to really imitate natural tooth structure on a long term basis, so it is best that it be retained as far as possible. Therapeutic methods for the control of the disease are available, and these should be the first line of defense. In the presence of early carious lesions, there is no justification for removal of tooth structure simply to provide a theoretic resistance to further carious attack or to develop mechanical retention for restorative materials. The new approach requires education in the profession, followed by education of our patients and third party payers. The surgical approach for the restoration of diseased tooth structure leads to loss of both esthetics and strength. It is also a self-propagating process where in one restoration often leads to another. The only acceptable reason, for preparing a cavity to treat a new caries lesion, is to eliminate cavitation on the tooth surface and to reduce plaque accumulation. This means minimal intervention in preparing for restoration.

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