MANAGEMENT OF DENTAL CARIES

DEPT. OF CONSERVATIVE DENTISTRY & ENDODONTICS
Management of dental caries

- Introduction
- Caries risk assessment and management
- Remineralization
- Chemical plaque controlling agents
- Pit and fissure sealant
- Ozone
- Atraumatic restorative treatment
- Preventive resin restoration
Management of dental caries

- Lasers
- Ultrasonic
- Air-abrasion
- Chemo-mechanical caries removal
- Cavity design for minimal invasive dentistry
- Restorative material used in MID
- Conclusion
- References
Definition

- Minimal Invasive Dentistry (MID) is defined as a philosophy of professional care, concerned with the occurrence, early detection and earliest possible cure of disease on a micro level, followed by minimally invasive treatment in order to repair irreversible damages caused by such disease.

Garg et al.; minimal invasive dentistry  BJMMR, 17(5): 1-9, 2016;
Principles

- Disease risk assessment & early caries diagnosis;
- The classification of caries depth and progression using Radiographs
- The reduction of cariogenic bacteria, to decrease the risk of further demineralization and cavitation
- The arresting of active lesions
• The remineralization and monitoring of non-cavitated arrested lesions

• The placement of restorations in teeth with cavitated lesions, using minimal cavity designs

• The repair rather than replacement of defective restorations

• Assessing disease management outcomes at pre established intervals.
Caries risk assessment is the determination of the likelihood of the increased incidence of caries during a certain time period or the likelihood that there will be a change in the size or activity of lesions already present.
The reference manual of pediatric dentistry
Caries risk indicators

Presence of caries lesions,
Low salivary flow,
Visible plaque on teeth,
High frequency sugar consumption,
Presence of appliance in the mouth, Health challenges, Socio-demographic factors,
Access to care
Cariogenic microflora

Protective factors

Child’s receiving optimally-fluoridated water,
having teeth brushed daily with fluoridated toothpaste,
receiving topical fluoride from a health professional,
having regular dental care
INTRODUCTION

DEMINERALIZATION

REMINERALIZATION
Demineralization occurs at low pH when the oral environment is undersaturated with mineral ions, relative to a tooth’s mineral content.

- Remineralization allows the lost calcium, phosphate, and fluoride ions to be replaced by fluorapatite crystals.

- These crystals are more resistant to acid dissolution and are substantially larger than the original crystals.
The remineralization is defined as the process whereby calcium and phosphate ions are supplied from a source external to the tooth to promote ion deposition into crystal voids in demineralized enamel to produce net mineral gain.
The pivotal discovery of fluoride as an agent that could prevent dental caries was one of the most important landmarks in dentistry.

Gold standard

Fluoride → Fluorapatite

Tencate *et al*
Delivery methods

- **Topical**
  - Sodium fluoride (30%)
  - Stannous fluoride (8% and 10%)
  - Acidulated phosphate fluoride

- **Systemic**
  - Community water fluoridation
  - Salt fluoridation
  - Milk fluoridation
  - Fluoride tablet/drops/lozenges
Mechanism of fluoride

Fluoride - inhibit cellular enzymes (enolase, proton extruding ATPase)
Bioactive glass

- Professor Larry Hench
- Developed as biocompatible bone regenerative agent
- 45S5
  - 45% SiO
  - 24.5% CaO
  - 24.5% Na₂O
  - 6% P₂O₅

Islam et al: Bioactive calcium phosphate–based glasses and ceramics and their biomedical applications: A review
Mechanism of action

Dr. Ming S. Tung

CPP-ACP

Milk product

- Strengthens remineralization
- Prevents dental caries

Delivered: via tooth mousse, chewing gum (chewing gum increases the salivary stimulation and the benefits of CPP–ACP are also present), mouth rinses and toothpastes and CPP–ACP helps in the reduction of tooth sensitivity when it is present in toothpastes.
Mechanism of action

CPP-ACP form nanocluster ACP
pool of Ca\(^{2+}\) PO\(_4\)\(^{-}\)
buffer solution
(Saliva)

Ca\(^{2+}\) PO\(_4\)\(^{-}\) (increase pH)
Aggregate

ACP crystals

Stable crystalline phase

A review of novel dental caries preventive material: Casein phosphopeptide–amorphous calcium phosphate (CPP–ACP)
**Indication:**
- Used to remineralize early carious lesions.
- Counteract the action of acids in cases of erosion.
- Edge over fluoride toothpaste when it comes to neutralizing acids in the oral cavity.
- Sensitivity
- Utilized as a prophylactic agent before the bonding of orthodontic brackets.

**Contraindication:**
Patients having intolerance to milk.
NANO-HYDROXYAPATITE

Biocompatible and Bioactive material

Morphology
structure
crystallinity

Phillip et al.; state of the art enamel remineralization
TRICALCIUM PHOSPHATE

- Alpha tricalcium phosphate
- Beta tricalcium phosphate

(Calcium phosphate and calcium hydrogen phosphate)

Laurence J. Walsh Contemporary technologies for remineralization therapies: A review
The O3 technology was developed by Prof. Dr. Edward Lynch.

Ozone therapy causes remineralisation of incipient pit and fissure caries as well as incipient root caries. Its usefulness in open lesions has also being demonstrated.

Jingarwar MM. et al., Minimal Intervention Dentistry – A New Frontier in Clinical Dentistry
How it works.....

Ozone readily penetrates through decayed tissue, eliminating the ecological niche of cariogenic micro organisms as well as priming the carious tissue for remineralisation. As ozone readily penetrates through decayed tissue, eliminating any bacteria, fungi and viral contamination, it would be expected that this ‘clean’ lesion would remineralise.
There are various dental ozone devices available (for example, the Heal Ozone and DentOzone unit.) Both these dental ozone units deliver ozone gas at pre-set concentration. At the end of a 30 to 60s ozone exposure, a mineral wash is placed over the treated area to kick-start the remineralisation process. Once ozone treatment has been completed as necessary, the patient is sent away with an ‘at-home care kit’.
Treatment is simple, fast (the average ozone time for practitioners using the Ozident® dental ozone unit is 30s) and involves little preparatory work. The loose debris is first cleaned away, until a leathery base is reached. This can be done with hand instruments.

Ozone is applied, the lesion wetted with a remineralising wash and then the glass ionomer (Fuji VII) can be applied. This modified ART technique has been reported by Holmes.
Preventive resin restoration

>This technique was 1\textsuperscript{st} introduced by Simonsen in 1977

> This combines the preventive approach of sealants along with the restoration of incipient caries with the composite resin on the same occlusal surface

Materials used in dentistry, S. Mahalaxmi
Preventive Resin Restoration (PRR)

- Fissure Sealant

**Type A**

- Fissure Sealant
- Composite Resin Base

**Type B**

- Fissure Sealant
- Posterior Composite Resin
- Base

**Type C**
ATRAUMATIC RESTORATIVE TREATMENT

This technique was pioneered in mid-1980s in Zimbabwe and Tanzania in the need for basic treatment of carious teeth in communities with limited resources.

Based on modern knowledge

- Minimal intervention
- Minimal invasion
- Minimal cavity preparation
Definition......

As a minimally invasive care approach in preventing dental caries and stopping its further progression

Jo E. Frencken, 2012

2 main principles

- Removing carious tooth tissues using hand instruments only
- Restoring the cavity with a restorative material that adheres to the tooth

Soben peter; essential of public health dentistry
The reason for using GIC

- As the glass ionomer adheres chemically to both enamel and dentin, the need to cut sound tooth structure to prepare the cavity is reduced.

- Fluoride is released from the restoration which will prevent and arrest caries.

- It is rather similar to hard tissues and does not inflame the pulp or gingiva.
Circular scooping movements of the excavator
Fracturing off unsupported enamel with a hatchet
Application of dentin conditioner
The cavity and adjacent pits and fissures are overfilled
Press the restorative material with gloved finger. Excess material is visible
Removal of excess material by carver blade
Indications

- Only in small cavities
- Those cavities which are accessible to hand instrument
- Public health programs

Contra-Indications

- Presence of swelling, fistula, pain
- Pulpal exposure
- Chronic inflammation of pulp
This systematic review revealed survival rates for single-surface ART restorations in permanent molars, i.e., 98.4%.
Air abrasion

Air abrasion was originally developed by Robert Black in 1945 as an alternative pseudo-mechanical method for dental tissue removal and the first air abrasion unit marketed was called the Airdent by SS White.
FIG. 7-31  Example of air-abrasion equipment used for tooth cleaning (Cavitron Jet, Dentsply Professional) showing the prophyl tip and handle attached by a flexible cord to the control unit with the reservoir of powder and source of water. (Courtesy of Dentsply Professional, 1301 Smile Way, York, PA, 17404-0807, phone: (800)989-8826)

FIG. 7-29  Example of contemporary air-abrasion unit for removal of superficial enamel defects or stains, debriding pits and fissures for sealant application, or roughening surfaces to be bonded or luted. (Courtesy of Lares Research, Chico, Calif.)
The speed of the abrasive particles when they hit the tooth depends upon the gas pressure, nozzle diameter, particle size, and distance from the surface

- Air pressure – 40-160 psi
- Particle size of alumina- 27 to 50 µm
- Operating distance- 0.5 to 2 mm.
- Higher particle flow rate will allow more particles to abrade the working surface faster.

Vivek S Hegde, A new dimension to conservative dentistry: Air abrasion, J Conserv Dent, Jan-Mar 2010, Vol 13, Issue 1
USES-

1. Removal of superficial enamel defects
2. Tool for detection of pit and fissure caries
3. Removal of pit and fissure surface stains on enamel before placement of a resin-based composite restoration
4. Box-preparation for class II cavities
5. Surface preparation of abfractions and abrasions
6. Removal of existing restoration

Vivek S Hegde, A new dimension to conservative dentistry: Air abrasion, J Conserv Dent, Jan-Mar 2010, Vol 13, Issue 1
Vivek S Hegde, A new dimension to conservative dentistry: Air abrasion, J Conserv Dent, Jan-Mar 2010, Vol 13, Issue 1
Not efficient means of removing large amalgam restorations

Not effective for removal of gross caries because it does not cut substances that are soft or resilient

Depth of penetration during cavity cannot be controlled

Cannot be used in conjunction with magnification devices such as loupes or dental operating microscopes

It produces round textured cavosurface margin and thus is not suitable for amalgam cavity preparation, metal inlay/onlay

Vivek S Hegde, A new dimension to conservative dentistry: Air abrasion, J Conserv Dent, Jan-Mar 2010, Vol 13, Issue 1
It should be avoided in cases involving severe dust allergy, asthma, chronic obstructive lung disease, recent extraction or other oral surgery, open wounds, advanced periodontal disease, recent placement of orthodontic appliances and oral abrasions, or subgingival caries removal.

Many of these conditions increase the risk of air embolism in the oral soft tissues.

Figure 3: Sandtrap placed on mandibular molar demonstrating ease of debris evacuation

Vivek S Hegde, A new dimension to conservative dentistry: Air abrasion, J Conserv Dent, Jan-Mar 2010, Vol 13, Issue 1
Effectiveness of high speed instrument and air abrasion on different dental substrates

Abstract: The aim of this study was to compare the effectiveness of high speed (HS) and air abrasion (AA) instruments on groups of teeth (deciduous, permanent, bovine), in terms of preparation time, topography and...
and also confirmed by the present study, was a round-shaped margin. This round contour not only favors adhesion and restoration placement, which reduces microleakage,\textsuperscript{24,25} but is also considered important for the longevity of adhesive restorations\textsuperscript{26} when associated with typical air abrasion cutting characteristics, namely, rough surfaces and a halo effect.\textsuperscript{16}
Resin infiltration technique is a novel technology that bridges the gap between prevention and restoration of carious lesions up to the first third of dentin (D-1) and can camouflage aesthetically disfiguring white lesions on the buccal surface.

- Interproximal caries
- Smooth surface caries
- White spots
- Marks in buccal and palatal surface

Linda Greenwall—White lesion eradication using resin infiltration
ADVANTAGES

• Noninvasive treatment, preserving tooth structure;
• Achieved in a single visit;
• Mechanical stabilization of demineralized enamel;
• Deeper penetration into porous demineralized areas;
• Arrest/retardation of lesion progress;
• Minimized risk of secondary caries;
• No risk of postoperative sensitivity and pulpal inflammation;
• Reduced risk of gingivitis and periodontitis;
• Improved esthetic outcome when used as a “masking” resin on demineralized labial surfaces (white spot lesions, i.e. with orthodontic patients);
• High patient acceptance.
Surface Layer Erosion of Natural Caries Lesions with Phosphoric and Hydrochloric Acid Gels in Preparation for Resin Infiltration

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The results of the present investigation revealed that 37\% H_3PO_4 gel is not suitable to remove the surface layer of natural lesions when applied for 30–120 s. In contrast, treatment with 15\% HCl gel for 90–120 s led to a virtually complete removal of the surface layer and therefore seems to be more suitable for the pretreatment of natural enamel lesions prior to resin infiltration. Notwithstanding, it could be argued that the removal of the surface layer might additionally weaken the lesion structure.
After a period of uncertainty concerning the use of lasers in dentistry at the end of the 1990s, three wavelengths available for clinical use in hard dental tissue management were developed.

These included the

1. Erbium:yttrium-aluminum-garnet Er:YAG (λ = 2940nm)

2. Erbium-chromium:yttrium-scandium-gallium-garnet Er,Cr: YSGG, (λ = 2790nm)
CLINICAL APPLICATIONS

- Cavity preparation
- Caries removal
- Restoration removal
- Etching
- Treatment of dentinal sensitivity
- Caries prevention
Mechanism of action

Erbium lasers have strong absorption by water and relatively low absorption by hydroxyapatite, making possible the cutting of enamel by the ablation process that is achieved by the absorption of laser energy by the water droplets contained in enamel, which results in water microexpansion and in the ejection of hard tissue.

Surface changes such as
Roughness
Cratering
Cracking
Fissuring
Melting
Brief Report

Effect of a Novel Er:YAG Laser in Caries Removal and Cavity Preparation: A Clinical Observation


These first clinical data on Smart 2940 D indicate that it is an efficient, effective, safe, and suitable instrument for caries removal and for cavity preparation. It shortens operation time greatly, without causing negative effects on clinical outcome. It offers a practical alternative to the vibratory and auditory irritation that the conventional turbine bur has in dental surgery.
any, damage or surrounding dental hard tissues can be detected by use of optical and SEM microscopes.\textsuperscript{19} The smear layer is efficiently removed. In fact, in comparison to Nd:YAG or argon lasers, Er:YAG is the most effective for smear layer removal.\textsuperscript{20} Neither Knoop hardness nor Ca/P ratio evaluations on the cavity floor revealed any significant difference between
Effect of Er:YAG Laser on Shear Bond Strength of Composite to Enamel and Dentin of Primary Teeth

Zahra Bahrololoomi\textsuperscript{1}, Mona Kabudan\textsuperscript{2\textsuperscript{*}}, Leila Gholami\textsuperscript{3}

difference was seen in laser without etching subgroups of dentin and enamel and the bond strength was low in both subgroups, which indicates that laser alone without acid etching does not provide optimal bond strength. Thus, if laser is to be used for tooth preparation, it must be necessarily accompanied by acid etch-
High frequency ultrasonic vibrations have been recommended since the 1950s to remove proximal carious lesions in both anterior and posterior teeth, with the aim of achieving a more conservative cavity preparation.

This technique does not physically excise the dentine, but abrades it using a diamond-coated tip oscillating at a frequency of about 6.5 kHz ranging to a maximum frequency of 20-40 kHz.

Sono-abrasion has been developed as a modification of the original ultrasonic method.

- Sono-abrasion is a technique for the selective preparation of enamel and dentine offering excellent efficacy, quality and safety.

- This technique utilizes high frequency, sonic, air scalers with modified abrasive tips which describe an elliptical motion with a transverse distance of 0.08-0.15 mm and a longitudinal movement ranges from 0.055 to 0.135 mm.
Advantages-
• Minimising or eliminating noise, vibration, heat and pressure.
• Helpful to modify the approximal preparation procedure in order to protect adjacent teeth against iatrogenic damage caused by the use of dental burs.

Disadvantages-
• Weakening of enamel rods with the associating cracks adjacent to the prepared sites.

Minimal intervention dentistry II: part 4. Minimal intervention techniques of preparation and adhesive restorations The contribution of the sono-abrasive techniques, BRITISH DENTAL JOURNAL, 2014
Instrument SF 849 009 SonicLine® (Komet) for pits and fissures, which allows opening and preparation of the carious distal occlusal fissure of tooth 27. a) Tip in place; b) Clinical result
Instrument 42 311 Sonicflex® (Kavo) (diamond-coated ball and shaft) used here for an occlusal micro-preparation where there are cavities in the cuspal tips (21-year-old patient; severe erosion since childhood)
CHEMO-MECHANICAL CARIES REMOVAL
• An alternative to the conventional mechanical removal of caries.

• This idea was developed by Goldman in 1970.

• Chemomechanical elimination of carious dentin has so far been promising particularly in pediatric dentistry especially for anxious or medically compromised patients.
The principle of chemomechanical caries removal is the use of a solution to chemically alter carious tooth tissue to further soften it, thus facilitating its easier removal. The softened dentine is then mechanically removed using a hand instrument.
indications

- Exposed buccal lesions;
- Cervical or root caries;
- Very deep carious lesions
- Treatment of the uncooperative paediatric patient or the older, frightened child.

Contra-indications

- sessions that necessitate short treatment time,
- pit and fissure caries that are not deep where rotary preparation will suffice to remove caries with little discomfort and the removal of hard eburnated part of the lesion.
Sodium hypochlorite (NaOCl) or Enzyme-based agents
Sodium hypochlorite (NaOCl)-based chemomechanical caries removal agents

- Chlorinate
- Hydrogen bonds
- Collagen
that the mean caries excavation time for GK-101 was 8.5 minutes and using burs remained an essential subsequent step in order to achieve ideal finishing of the excavated sites.
GK-101E (CARIDEX)

GK-101E is the ethyl derivative [N-monochloro-DL2 amino butyrate (NMAB)] of GK-101 (NMG)

The mechanism of action of NMAB on denatured collagen fibrils was similar to that of NMG, which involved the chlorination of the partially degraded collagen in the carious lesion and the conversion of hydroxylproline to pyrrole-2- carboxylic acid.
However, the unpleasant taste indicated by few patients and the lengthy procedure (10-15min), in addition to the large volumes of solution needed (200-500ml) and to the fact that the delivery system was no longer commercially available, limited the use of caridex clinically.
Carisolv

The original Carisolv was red in colour, consisted of two syringes; one containing carboxy-methylcellulose-based gels and amino acids (glutamic, leucine and lysine); the other containing 0.25% NaOCl.
THE MECHANISM OF ACTION of Carisolv was similar to Caridex, except that the monoaminobutyric acid was replaced by three different amino acids glutamic, leucine, lysine). The amino acids were shown to react with different moieties of carious lesions.

Caries excavation times- 10.4 ±6.1 min
Enzyme-based chemomechanical caries removal agents

PapacarieTM (papain-based gel, Formula & Acao, Sao Paulo, Brazil),

BiosolvTM (SFC-V gel, 3M-ESPE AG, Seefeld, Germany)

H Hamama, Current update of chemomechanical caries removal methods, Australian Dental Journal 2014
Papacarie gel was introduced in 2003 by Bussadori et al.

- It consists of papain enzyme, chloramine, toluidine blue, salts, preservatives, a thickener, stabilizers and deionized water.

H Hamama, Current update of chemomechanical caries removal methods, Australian Dental Journal 2014
• Papain is a proteolytic enzyme with bactericidal and anti-inflammatory actions.

• It is extracted from the latex of leaves and fruits of the green adult *Carica papaya* tree.
Dental prophylaxis using a rubber cup, pumice and use of rubber dam

The application of Papacarie is done for 30s in acute caries and 40 to 60s in chronic carious lesions.

After this period, the softened infected dentin is removed with a blunt instrument manual.

If all carious tissue has not been removed, the gel is reapplied until the cavity presents with a glassy finish.
RESTORATIVE MATERIALS USED IN MINIMALLY INVASIVE DENTISTRY
Adhesive dental materials make it possible to conserve tooth structure using minimally invasive cavity preparations, because adhesive materials do not require the incorporation of mechanical retention features.
GLASS IONOMER CEMENT

The advantages of GICs include adhesion to tooth and release of fluoride and other ions. They perform well in low stress areas. GICs release fluoride, calcium and aluminum ions into the tooth and saliva.

GICs’ disadvantages include technique sensitivity.

Kinch et al; MINIMAL INVASIVE DENTISTRY; JADA, Vol. 134, January 2003
INDICATIONS
• ART
• ROOT CARIES
• LINERS AND BASES

CONTRAINDICATION-
• DEFINITIVE RESTORATION
Resin-based composite/dentin bonding agents.

- The effective bonding of resin to enamel is a key factor in the selection of these materials.

- Though etching dentin and enamel and formation of a hybrid layer has improved the quality of the bond and the technology is constantly improving, polymerization shrinkage and marginal leakage continue to be a problem when margins are in dentin.
POLYMERIC CUTTING INSTRUMENT
Polymeric burs

- If the bur touches sound or caries-affected dentin, it quickly becomes dull and produces undesirable vibration, making further cutting impossible.

- The blade design was developed to remove dentin by locally depressing the carious tissue and pushing it forward along the surface until it ruptures and is carried out of the cavity.

- As opposed to conventional carbide burs, their cutting edges were not spiraled but straight.
Disadvantage: to excavate caries from the center to the periphery in order to avoid contact with sound tooth tissue. When in contact with sound dentin, the bur would be prematurely and irreversibly damaged.

eg. SSWhite
Nairn H F Wilson, MINIMALLY INVASIVE DENTISTRY: THE MANAGEMENT OF CARIES
Ceramic burs

- Slow-speed rotary cutting instruments made of ceramic materials for removal of carious dentin.
- Eg. CeraBurs: all-ceramic round burs made of alumina-yttria stabilized zirconia and are available in different diameter sizes.
- The manufacturer claims that besides its high cutting efficiency in infected, soft dentin, the use of this instrument for caries removal replaces both the explorer and the excavation spoon by simultaneously providing tactile sensation, self-evidently reducing preparation time.
MINIMAL TOOTH PREPARATION
TUNNEL PREPARATION

• It could be used when the lesion is more than 2.5mm below the crest of the marginal ridge and the contact area may remain sound and the marginal ridge may remain sound and the marginal ridge may be quite strong.

• Access to the lesion through the occlusal surfaces should be limited to the extent required to achieve visibility and should be undertaken from an area that is not under direct occlusal load.
• Access may be gained through the occlusal surface with No.2 bur about 2.0mm from the marginal ridge.

• Resin-modified glass ionomer cement is the current material of choice for this restoration. They are radiopaque and have been shown to prevent microleakage.
FIG. 16-14 Types of amalgam tooth preparations. A. Conventional. B. Box-only. C. Tunnel.
• It could be used when the lesion is less than 2.5mm below the crest of the marginal ridge.

• The basic principles of cavity design remain the same, with the objective of removing only that tooth structure that has broken beyond the possibility of remineralization.
The ultimate goal is to extent life of restored tooth with as less intervention as possible.

When operative care is indicated it should be aimed at “PREVENTION OF EXTENSION” rather than “EXTENSION FOR PREVENTION”.
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