

# Minimally Invasive Dentistry – A Review

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## Abstract

Minimal intervention dentistry initiates from the traditional surgical approach to the elimination of caries lesions seen as radiolucencies in the inner half of the enamel, at the dentin-enamel junction, and slightly into dentin, with the removal of the minimal amount of healthy tooth structure. Dental adhesives and restorative materials, changes in remineralization, caries process, and prevalence have revolutionized the caries management from G. V. Black's "extension for prevention" to "minimally invasive."

**Keywords:** Caries diagnosis, minimally invasive dentistry, remineralization

## INTRODUCTION

Minimum invasion dentistry (MI) is defined as a philosophy of professional care, concerned with the occurrence, early detection, and earliest possible cure of disease on a microlevel, followed by minimally invasive treatment to repair irreversible damages caused by such disease.<sup>[1]</sup> To overcome the G. V. Black's "extension for prevention" and to reduce the size of cavity preparation, the minimal intervention paradigm stresses the use of adhesive restorative materials.<sup>[2,3]</sup> This article gives an overview of the concepts of minimal intervention dentistry, describes suggested techniques for a minimally invasive operative approach, and reviews clinical studies which have been carried out in this area.

## HISTORICAL BACKGROUND

The use of silver diamine fluoride 2 as a minimally invasive procedure in dentistry was pioneered in the early 1970s.<sup>[4]</sup> Soon after, many innovations came forth with the objective of prevention of caries. In the 1980s, preventive resin restoration (PRR)<sup>[5]</sup> was developed, followed by atraumatic restorative treatment (ART) in the 1980s, and chemomechanical caries removal concepts in the 1990s.<sup>[5]</sup>

## GOLDEN TRIANGLE OF MID

A thorough understanding and appreciation of the interplay between three critical factors is required to achieve success

clinically when using a minimally invasive operative caries management strategy (MI OCMS):<sup>[6,7]</sup>

1. The histology of the dental substrate being treated
2. The chemistry/handling of the adhesive materials used to restore the cavity
3. Consideration of the practical operative techniques available to excavate caries minimally.

## CORE MINIMUM INTERVENTION PRINCIPLES

The four core principles of MID can be summarized as follows:

1. Recognition – to identify and assess any potential caries risk factors early, through lifestyle analysis, saliva testing, and using plaque diagnostic tests
2. Reduction – to eliminate or minimize caries risk factors, through altering fluid balance, reducing the intake of dietary cariogenic foods, addressing lifestyle habits such as smoking, and increasing the pH of the oral environment<sup>[8]</sup>
3. Regeneration – to arrest and reverse incipient lesions, regenerating enamel subsurface lesions, and arresting root surface lesions using appropriate topical agents including

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- fluorides and casein phosphopeptides-amorphous calcium
4. Repair – when cavitation is present and surgical intervention is required, as much as possible of the tooth structure is maintained using conservative approaches to caries removal. Bioactive materials are used to restore the tooth and promote internal healing of the dentin, particularly in cases of deep dentin caries, where the risk of iatrogenic pulpal injury is high.

## CONCEPT OF MINIMUM INTERVENTION

The concept of minimal intervention dentistry initiates from the traditional surgical approach to the elimination of caries lesions seen as radiolucencies in the inner half of the enamel, at the dentin-enamel junction, and slightly into dentin, but with little or no evidence of cavitations. Preservation of natural tooth structure should be the guiding factor.<sup>[9,10]</sup> Cavity preparation design and restorative material selection must depend on the occlusal load and wear factors.<sup>[2]</sup>

An appropriate classification for assessing radiographic changes in proximal radiolucencies is as follows: E1 = outer half of enamel

- E2 = inner half of enamel
- D1 = outer third of dentin
- D2 = middle third of dentin
- D3 = inner third of dentin.

## THE MINIMAL INTERVENTION APPROACH

It includes:

1. Caries diagnosis
2. Early restoration
3. Caries control.

## DISEASE RISK ASSESSMENT AND EARLY CARIES

### DIAGNOSIS

#### Risk category

- High risk – The presence of a single risk indicator in any area of the “high risk” category is sufficient to classify a child as being at “high risk”<sup>[11,12]</sup>
- Moderate risk – The presence of at least 1 “moderate risk” indicator and no “high risk” indicator results in “moderate risk” classification
- Low risk – The child does not have “moderate risk” or “high risk” indicators.<sup>[1]</sup>

#### Caries diagnosis

Earliest caries detection, traditionally by use of mirror and light, as well as bitewing radiographs, can now be aided by new developments in dental magnification and imaging, laser fluorescence, or quantitative light-induced fluorescence. One of the latest methods used nowadays is optical coherence tomography – it is an optical ultrasound that emits no radiation and provides detailed information to operator.

## Remineralization of early lesion and reduction in cariogenic bacteria

In the non (1–5) cavitated lesion, to take advantage of the tooth’s capacity to remineralize, one must first alter the oral environment, to tip the balance in favor of remineralization, and away from demineralization. This approach includes:

- Decreasing the frequency of intake of refined carbohydrates
- Ensuring optimum plaque control
- Ensuring optimum salivary flow
- Conducting patient education.

Agents such as chlorhexidine and topical fluorides can be applied to encourage remineralization. Chlorhexidine acts by reducing the number of cariogenic bacteria.<sup>[4,7]</sup>

## ADHESIVE RESTORATIVE MATERIALS

If the caries lesion has reached the stage of cavitation making plaque control difficult or impossible, a surgical approach is generally required. The infected tissue must be removed and replaced with a suitable restorative material, such that form and function are restored, and the patient is able to re-establish excellent plaque control. The advent of adhesive restorative materials has enabled minimal intervention principles to be applied to cavity preparation, and the materials which can be used for this purpose are described here.<sup>[9]</sup>

They are classified as:

- a. Passive smart materials
  1. Glass ionomer cement (GIC)
  2. Resin-modified GIC
  3. Composite adhesive resin
  4. Compomers
- b. Active smart materials
  1. Ariston pHc alkaline glass restorative
  2. Amorphous calcium phosphate composite EQUIA restorative system-It includes a high viscosity GIC (EQUIA Fil or Fuji IX GP Extra) with a highly-filled, light curing varnish (EQUIA Coat or G-Coat Plus)-It has advantages of high-viscosity GIC (self-adhesion, bulk application, improved mechanical properties) and protective resin coating which increases its fracture toughness and reduces microleakage-indication-cost effective, mercury free and Aesthetic tooth restoration.

## Preventive resin restoration

PRR is indicated in teeth with minimal teeth and fissures decay. In this, minimal cavity preparation is required to prevent unnecessary removal of healthy tooth structures for retention. If the decay is limited to enamel, then no local analgesia is required. After etching, rinsing, and drying, the cavity is condensed with a normal composite or GIC.

## Atraumatic restorative technique

ART approach involves the removal of only soft, demineralized tooth tissue with hand instruments, followed

by filling the cleaned cavity and associated pits and fissures with adhesive restorative materials.<sup>[6]</sup>

### Chemomechanical methods

This involves the application of a chemical solution to the caries, selectively softening the carious dentin, facilitating its removal with mechanical hand instruments, and without affecting sound noncarious dentin (Morrow *et al.*, 2000; Ericson *et al.*, 1999). The most efficient system available is Carisolv™ (Mediteam Dental, Gothenburg, Sweden). Carisolv can be used solely or in combination with other methods that may be required to gain access to the lesion. This method is particularly suitable for root surface caries and large cavitated coronal cavities. It has the advantage of not usually requiring the use of local anesthesia.<sup>[9]</sup>

### Sonic tooth preparation

This utilizes the vibrational energy of ultrasonically vibrated metal tips, rather than rotation. It allows precise minimal cutting preparation using diamond-coated tips.<sup>[11,12]</sup>

### Air abrasion

This utilizes a stream of 27.5-micron aluminum oxide particles under air pressure to remove tooth substances by brittle fracture. It produces less heat, sound, or vibration compared to high-speed instrumentation and does not induce microfractures.

### Lasers

The mechanism of hard tissue removal is basically an explosive subsurface expansion of the interstitially trapped water, with the rapid ejection of tooth particles in the opposite direction to the incoming laser beam. As carious tooth structure has a higher water content than sound tooth, it is rapidly and effectively removed by the laser energy.

## Cavity Designs for Minimal Invasion Dentistry

### 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 dentin 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

Specific designs for approximal lesions:

- i. Tunnel preparation
- ii. Microchip cavity preparation
- iii. Minibox cavity preparation
- iv. Full box cavity preparation.

## ADVANTAGES OF MINIMUM INTERVENTION DENTISTRY

Minimal intervention applies a more conservative approach to caries treatment and simultaneously offers patients less invasive, health-oriented treatment options. The benefit for patients from MI lies in better oral health, minimizing the restoration cycle, and reducing the patient dental anxieties. MI includes clinical procedures such as assessment of caries risk, early detection of the disease, followed by restoration of fissure caries with maximum retention.<sup>[11]</sup>

## CONCLUSION

In the 21<sup>st</sup> century, greater emphasis must be placed on assessing caries risk, shifting patients to a low caries risk status, remineralizing noncavitated lesions, abandoning the surgical approach to caries management, and repairing rather than replacing defective restorations. There is a clear need for research to improve the sensitivity of diagnostic methods, to develop site-specific indicators of future caries risk, and to establish clear guidelines on the management of caries as an infectious disease.

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