

## Minimally Invasive Dentistry – A Contemporary Headway in the Domains of Dentistry.

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**Abstract:** Minimally Invasive dentistry is not just a technique, but it is a philosophy related to preservation of lost tissue rather than their meticulous removal. Remineralizing agents such as Bioactive Glass, SDF, self-protecting assembly P<sub>11-4</sub>, nanohydroxyapatite play a major role in preventive dentistry. Caries management strategies like, SMART, sonic system, polymer(SMART) burs and laser are advanced techniques which are far beyond simply “drilling & filling” of the teeth. Minimally invasive endodontics includes conservative access cavity preparation like Ninja cavity & root canal flaring which will reduce fracture of crown & root. Lasers, micro-marsupialization are simple, easy to perform, minimally invasive surgeries used in paediatric patients. This article enfocuses on recent evolutions in all the aspects of dentistry which are minimally invasive.

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### I. Introduction

For almost the whole of a century, operative dentistry was greatly influenced by Dr. G.V. Black. Black's principles of cavity preparation were based on the facts about dental caries known in his time and on the dental materials available at that time. His concept of “extension for prevention” included, extension of cavity outline into the uninvolved pits and fissures to prevent recurrence of caries in the tooth.<sup>1</sup>This resulted in a “surgical” approach to treatment planning rather than a “biologic” or “therapeutic” one. Advances in instrumentation, materials & technique have enabled the clinicians, a transition from G.V. Black's "Extension for prevention" to "Prevention of extension" approach in caries management.<sup>2</sup>

Minimally-invasive treatment in dentistry was pioneered in the early 1970s with the application of diamine silver fluoride. This was followed by the development of the preventive resin restoration (PRR) in 1978 and the atraumatic restorative treatment (ART) in 1980s approach and chemo-mechanical caries removal concepts in the 1990s. The ultraconservative treatment concepts in MID are applied with the intention to preserve as much tooth tissue as possible and to offer more patient-friendly care to fearful patients.

### II. Basic Concepts Of Mid:

The concept of minimally invasive dentistry has evolved as a consequence of our increased knowledge and understanding of the caries process and development of adhesive restorative materials. In the present era, the practice of dentistry emphasizes more on prevention and remineralization of caries whenever possible rather than simply “drilling and filling” of the teeth. However in certain circumstances, a surgical approach is inevitable, and adhesion between the restorative material and both enamel and dentin is an important component for prevention of secondary caries and pulp damage.

Minimally invasive dentistry is not just a technique, but a philosophy related to preservation of loss of tissue rather than their overzealous removal. No formal definition have been proposed for this pattern of dentistry, however it is based on certain principles, which are as follows –

1. Early detection.
2. Remineralization of early enamel lesions.
3. Reduction in cariogenic bacteria, in order to eliminate the risk of further demineralization and cavitation.
4. Minimal surgical intervention.
5. Repair, rather than the replacement of defective restorations.
6. Disease control.

This topic enfocuses on all the aspects in dentistry which are minimally invasive.

### **III. Minimally Invasive Diagnostic Aids:**

- **EXTENSIVE CLINICAL OBSERVATION:**

- A. The purpose of the examination is to detect visually changes of colour, translucency and structure of the enamel. The use of visual aids (magnifying loupes, minimum  $\times 2.5$ ) greatly improves the detection rate of initial carious lesions. The changes in colour and translucency of enamel indicate the state of demineralisation of surfaces and sub-surface zones compared with adjacent healthy areas. These visible signs indicating caries, have been rationalised in a classification system, the International Caries Detection and Assessment System (ICDAS).<sup>3</sup> The classification includes six codes:

ICDAS Code	Criteria for visual lesion detection
<b>0</b>	Sound surface
<b>1</b>	Earliest optical change, visible on drying enamel
<b>2</b>	Clear enamel change; white or brown blemishes, visible without drying
<b>3</b>	Localised break in enamel
<b>4</b>	Dentine not visible
<b>5</b>	Enamel opaque or greyish, suggestive of an underlying dentine lesion, with or without enamel cavitation
<b>6</b>	Dentine cavity

- **VISUAL EXAMINATION ASSISTED BY PROBING:**

Tactile sensation has long been the principal diagnostic tool in cariology, involving the use of a sharp dental explorer. It is helpful in detecting lesions in pits and occlusal fissures. Furthermore, probing can cause iatrogenic damage to enamel so favouring lesion progression. Probing with a sharp dental explorer cannot be considered a reliable technique for detection of carious lesions.

- **RADIOGRAPHIC EVALUATION**

Bitewing radiographs are the method of choice for early detection of carious lesions, especially on proximal surfaces. Radiographic examination also allows the depth of a carious lesion to be estimated, useful for care planning. The technique involves using a specific film holder with a guide rod and a collimator ring (Rinnangulator).

- **NEW DIAGNOSTIC AIDS**

The development of new diagnostic aids is based on the need for increased detection sensitivity to allow lesions to be identified as early as possible. The new diagnostic tools are classified on the basis of the physical principles that underpin them. The most prominent include transillumination (Diagno.cam, Kavo®) and fluorescence systems (DIAGNOdent, Kavo®; CS 1600 Kodak; VistaCamiX, DürrDental®; SoproLife, Acteon®).

- **OPTICAL TECHNIQUES**

- Optical aids-** The visual examination requires optical magnification to be properly conducted. The use of Galilean loupes (magnification  $\times 2-5$ ) is satisfactory for daily practice.
- Scanned images-** Conventional intraoral cameras allow direct viewing of the captured image but their quality is not always satisfactory for diagnosis.
- Fluorescence systems-** Fluorescence is light emission provoked by excitation of the molecules in a material due to the absorption of high energy light. This fluorescence helps to selectively remove carious lesions.
- Infrared laser-** The red light and the subsequent fluorescence emissions are carried via optical fibres. Some authors agree that this system has better sensitivity than visual or radiographic examination.
- Quantitative light fluorescence (QLF)-** This technique uses an intraoral camera with CCD technology linked with system for emitting light in the blue/blue-green wavelengths. The fluorescence of the teeth is rendered on a screen after the blue light is filtered out, leaving green light for the image. This system has been considered to be superior to visual examination for detection of initial carious lesions.
- LED cameras-** The newest detection system for carious lesions is the use of intraoral cameras with LED technology. These systems illuminate the tooth, record the fluorescence of the dental tissue and enhance the image using dedicated software. As with QLF systems, the healthy enamel appears green. Demineralised enamel appears blue and dentine is yellow to red, depending on the severity of the demineralisation.

### **IV. Minimally Invasive Preventive Procedures:**

Enamel demineralization is a process which begins at a pH below the critical pH of enamel (pH<5.5). This process is reversible provided that the acidogenic environment of the oral cavity gets neutralized; whereas enamel remineralization is a natural repair process for non-cavitated lesions and depends on precipitation of

calcium, phosphate and fluoride ions on the tooth to form a new mineral.<sup>4</sup> The preventive aspect includes various remineralizing agents viz. fluorides, xylitol, nanohydroxyapatite and other calcium and phosphate based remineralizing agents; but, in order to achieve a biomimetic remineralization, the long standing usage of calcium-phosphate based remineralizing agents ceased and the newer agents such as P11-4, Bioactive Glass came into existence in the preventive field.

Low levels of calcium and phosphate can limit enamel remineralization process, when topical fluoride is applied.<sup>5</sup> CPP-ACP consists of casein phosphopeptide – amorphous calcium phosphate complex. Casein in CPP can adjust to acid-base environment. In acidic pH, ACP separates from CPP, which leads to an increase in calcium and phosphate levels in saliva and helps in maintaining a state of supersaturation with respect to site.<sup>4</sup> The CPP-ACP complexes are stable in the presence of fluoride and have been shown to inhibit demineralization and enhance remineralization.<sup>6</sup> CPP-ACPF with 0.2% F content has been reported to have a greater potential for remineralization than CPP-ACP.<sup>5</sup>

A calcium and phosphate based remineralizing agent which is based on Anticay technology is a mixture of calcium sucrose phosphate with inorganic calcium phosphates, consisting of 10-12% calcium and 8-10% phosphorous by weight.<sup>7</sup> Calcium sucrose phosphate breaks down into calcium, phosphate and sucrose phosphate ions and acts as a carrier for calcium and phosphate ions in water and saliva. Calcium and phosphate ions are rapidly adsorbed on the tooth surface. These ions are mainly responsible for remineralization of tooth enamel by their common ion effect. Sucrose phosphate ion decreases rate of acid dissolution of hydroxyapatite and inhibits demineralization of tooth enamel.<sup>8</sup>

The remineralization of teeth with fluoride is achieved through the formation of fluorapatite, which is based on the epitaxial growth of the residual crystals. However, due to the lack of ability to guide the formation of mineral crystals, it is difficult for fluoride to result in oriented and ordered mineral crystals on the surface of enamel under physiological conditions. The mineral crystals in mature enamel are highly elongated and oriented prisms of hydroxyapatite. Thus, an ideal mineralizing material should achieve the organization and micro-architecture of mineral crystals that mimic natural ones to the greatest extent possible.<sup>9</sup>

Glycine-guided remineralization mimics the natural biomineralization process, where well-oriented rod-like hydroxyapatite crystals are formed which recovers the mechanical properties of the demineralized enamel.<sup>9</sup> Xylitol when applied over the demineralized surface of enamel, releases calcium and phosphate in the saliva which in turn reduces the acid formation due to the reduced fermentation of bacteria. This leads to the stimulation of saliva and its increased pH remineralizes the carious lesion. Xylitol reduces the levels of mutans streptococci (MS) in plaque and saliva by disrupting their energy production processes, leading to cell death. This reduces the adhesion of streptococcus mutans to the teeth surface and also reduces its virulence properties. Hence, xylitol acts as a bacteriostatic agent. The uniqueness of xylitol is that it is practically nonfermentable by oral bacteria.<sup>10</sup>

Silver Modified Atraumatic Restorative Technique (SMART) is an alternative caries prevention tool that advances the existing armamentarium. Silver diamine fluoride entered the US market in 2015, whereas since 19<sup>th</sup> century it is used in treating tooth sensitivity. In this technique, silver diamine fluoride is applied and immediately restored with the conventional GIC. Placement of SDF (pH-10) and GIC on the same appointment is useful when dealing with patients that may have trouble managing multiple appointments and lacks regular access to care. By placing SMART restoration, the bacteria are killed and the nutrient source is cut off for any remaining bacteria by placing a chemically sealed restoration that will arrest and remineralize the carious lesion, preserving the tooth structure and enhancing pulp vitality.<sup>11</sup> Single application has been reported to be insufficient for sustained benefit, while annual re-application results in remarkable success, and even greater effects with semi-annual application.<sup>12</sup>

The recommended limit of SDF is about 1 drop (25  $\mu$ L) per 10 kg per treatment visit.<sup>12</sup> SDF reduces the colony-forming unit (CFU) counts of *S. mutans*, *Actinomyces naeslundii* and *Lactobacillus acidophilus*. SDF also inhibits the adherence of *S. mutans* to tooth surfaces. SDF promotes absorption of calcium in the presence of remineralizing solution. Also, it inhibits calcium dissolution from enamel in the presence of demineralising solution.

## **V. Minimally Invasive Operative Procedures:**

In panorama of major population, “Dental venture is one of the most arduous procedures they can have experienced”. The injection site, noise and vibration caused by dental drilling machines is the most well-known cause of fear and anxiety. This can be eliminated using novel operative techniques such as air abrasion, chemo-mechanical caries removal, FACE (Fluorescence Aided Caries Excavation) and through polymer burs and lasers.

Bioactive Glass air abrasion is a prudent technique of removal of only the decalcified tissues of the teeth, preserving the tooth structure via the release of minerals. The abrasive particles interact with the carious lesion enhancing remineralization.<sup>13</sup>

Chemo-mechanical methods of caries removal works on the art of using a selective reagent which degrades and partially solubilizes the degraded dentin collagen present in the tooth.<sup>14</sup>This method has been an explication for the treatment of patients pursuing substitutes to conventional methods. In Fluorescence Aided Caries Excavation, the violet light (370–420 nm) which is fed into the fiberoptics of a slow-speed handpiece illuminates the operating field during excavation. Then the areas exhibiting orange-red fluorescence are selectively removed.<sup>15</sup>These areas are observed by an operator through a 530nm yellow glass filter in a darkened room. There are several micro-organisms (*F. nucleatum*, Streptococci, Lactobacilli, Actinomycetes, *P. intermedia*) which are known to produce fluorescing molecules or ‘fluorophores’ that emit yellow to red area of visible spectrum under excitation wavelengths.<sup>16</sup> Polymer burs, lasers selectively removes the dentinal caries. These polymer burs are self-limiting when they approach the sound dentin, hence preserving the sound tooth structure and hence described as “dentin safe”. Smart-prep polymer burs are a relatively recent and naval introduction for selective dentine caries removal.<sup>17</sup>

### **VI. Minimally Invasive Surgical Procedures:**

The surgical aspect includes lasers, micro-marsupialization and frenectomy which are minimally invasive surgeries. The traditional frenectomy technique is performed using local anaesthesia, scalpels for incisions and sutures. All this requires surgical dexterity as well as the capacity to work with small patients. Laser technique is an excellent alternative to the traditional surgery. It is simple and rapid to perform, well accepted and tolerated by the patients; requires minimal anaesthesia, with an asymptomatic post-operative period, without relapse. Different wavelengths can be utilized for this procedure and the principle concept to remember for all the wavelengths is that the minimum effective energy must be used because, lower the energy applied, less the damage on the targeted tissue and faster the healing process. Erbium: YAG laser with 2940nm wavelength can be used in paediatric patients. 1.5W at 20pps is a commonly used average power to easily, safely and quickly cut off the frenum.<sup>18</sup>

Mucocele is a common oral lesion in children and adolescents. Different techniques have been described for the treatment; however all of them are invasive and they are not always tolerated by the children or their parents. Micro-marsupialization is a surgical technique that involves incising into a cyst and suturing the edges of a subsequent slit to form a continuous surface from the exterior to the interior of the cyst. Micro-marsupialization consists in draining the accumulated saliva and creating a new epithelialized tracts along the path of the sutures. It is a minimally invasive technique, and most cases can be carried out under topical anaesthesia alone. The required procedure time is brief (approx. 3min), there is practically no tissue damage or inflammation, and it appears to be a particularly suitable technique for children who cannot tolerate long or invasive procedures.<sup>19</sup>

### **VII. Minimally Invasive Endodontic Procedures:**

Minimally invasive endodontics includes the ultra-conservative access cavity preparation like the NINJA endodontic cavity (NEC) preparation. In NEC preparation, the premolar and molar teeth were accessed in the same way as that of the conservative endodontic cavity (CEC) preparation. Here the chamber roof is maintained as much as possible. The access “NINJA” outline is derived from the oblique projection towards the central fossa of the root canal orifices on the occlusal plane. This allows localization of all the root canal orifices from different visual angulations because the endodontic access is parallel with the enamel cut at 90° or more to the occlusal table. The extension is equally balanced between the buccal and the lingual / palatal orifices.<sup>20</sup>

Precise, minimally invasive endodontic procedures are carried out with the help of ESX files. These ESX files have patented alternating contact point (ACP) design, which efficiently cleans 3 dimensionally, as the sharp cutting edges engage with the canal walls at opposing intervals. Due to their alternate asymmetrical flute design, the debris moves coronally in a wave-like fashion. The patented ACP design allows the ESX to operate at a low torque setting and higher speed, thereby reducing stresses on the file as well as on the root. ESX files have sharper cutting edges. They maximize safety and efficiency and allows for fewer instruments. The patented booster tip is like having two files in one.

### **VIII. Conclusion**

The benefit for patients from MI lies in better oral health through disease healing, not merely symptom relief. Furthermore, MI may assist in reducing widespread patient dental anxieties, which are usually caused by conventional, highly invasive dental procedures. This evolution of minimum intervention in the history of dentistry have taken the dental professionals to a point where the patients can be treated quickly, easily and comfortably.

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