



## Minimally Invasive Dentistry

### Full Summary

#### ***Minimally Invasive Dentistry Defined:***

Minimally invasive dentistry (MID) is an evidence based intervention approach supported internationally that aims to do the least harm to effected and surrounding tissues.[1, 2] This intervention strategy employs individualized risk assessment and the early detection of carious lesions. Treatment includes efforts to remineralize non-cavitated lesions and conservative operative procedures that maintain tooth structure.[3] Prevention is a key component of MID, an area which has been historically neglected by the treatment oriented oral healthcare agenda of many countries. However, the need for early prevention has been recognized by the World Health Organization and the World Health Assembly, which have both provided recommendations to governments and health systems to build integrated preventive services between oral and primary health care.[4] In order to communicate effectively about Cariology (and MID) among dental care providers, an Internationally agreed glossary of terms has been provided and adopted by the FDI World Dental Federation [3] to assure consistency of language:

Caries Lesion/Carious Lesion: A caries/carious lesion is a detectable change in the tooth structure that results from the biofilm-tooth interactions occurring due to the disease caries. These interactions cause changes in the tooth mineral structure as well as in the much less plentiful organic parts of tooth structures.[3]

Caries/Carious Lesion Detection: A process involving the recognition (and/or recording), traditionally by optical or physical means, of changes in enamel and/or dentine and/or cementum, which are consistent with having been caused by the caries process.[3]



Caries/Caries Lesion Assessment: The evaluation of the characteristics of a caries lesion, once it has been detected. These characteristics may include optical, physical, chemical or biochemical parameters, such as color, size or surface integrity.[3]

Caries Diagnosis: The human professional summation of all signs and symptoms of disease to arrive at an identification of the past or present occurrence of the disease caries.[3]

White –spot Lesion: A caries/carious lesion which has reached the stage where the net subsurface mineral loss has produced changes in the optical properties of enamel such that these are visibly detectable as a loss of translucency, resulting in a white appearance of the enamel surface.[3]

Demineralization: The loss of calcified material from the structure of the tooth. This chemical process can be biofilm mediated – i.e. as in caries – or chemically mediated – i.e. as in erosion – from exogenous or endogenous sources of acid – e.g. from the diet, environment or stomach.[3]

Remineralization: The net gain of calcified material within the tooth structure, replacing that which was previously lost by demineralization.[3]

Caries Lesion Activity (Net Progression): The summation of the dynamics of the caries process resulting in the net loss, over time, of mineral from a caries lesion – i.e. there is active lesion progression.[3]

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Arrested or Inactive Caries Lesion: A lesion which is not undergoing net mineral loss – i.e. the caries process in a specific lesion is no longer progressing. [3]

Remineralized Caries Lesion: A caries lesion which exhibits evidence of having undergone net mineral gain – i.e. there is replacement of mineral which was previously lost due to the caries process.[3]

The philosophy of MID centers on early diagnosis, risk assessment, remineralization of early non-cavitated lesions and the preservation of tooth structure when restorations are absolutely necessary.[5] The minimally invasive philosophy aims to maintain optimal oral health through comprehensive preventive measures based on *patient-centered management/monitoring* of caries. Early diagnosis can facilitate the arrest and remineralization of early non-cavitated lesions. Individualized risk assessment collectively predicts an individual's risk of acquiring a disease and mitigates future risk through management of risk factors. Early detection also informs appropriate prevention and treatment options. The preservation of tooth structures guides treatment decisions, with restorations and surgical interventions minimized accordingly. Hence, the diagnosis of a carious lesion is not sufficient cause for restorative operative treatment.[4] This marks a transition in the wide spread culture of restorative care in dentistry towards a preventive framework. Traditional methods can result in a cycle of restorative procedures over time, leading to continual loss of tooth structure.[6, 7] Under MID intervention, the quality of care should be assessed not by the quality of restorations, but by the preservation of dental structures and the promotion of oral health, which can be measured by “the prevention and arrestment of any caries activity in an individual over a period of time.”[4]



### ***Early Diagnosis and Remineralization***

Early diagnosis of carious lesions is cornerstone to the remineralization of non-cavitated lesions. However, many widely used classification systems record caries only at the dentinal level of detection and or do not assess level of activity.[8] The International Caries Detection and Assessment System (ICDAS) provides an evidence and preventive based protocol to visually detect and classify caries staging based on histological extent and activity.[4] This protocol provides common terminology and classification of caries for clinicians, researchers, public health professionals and educators globally. The ICDAS protocol allows for the classification of caries into categories based on histological extent of lesions spreading into the tooth tissues. Additionally, the ICDAS classification allows for the comparability of caries data collection across populations as well as across time points. An educational software package is available to assist in the education of students and clinicians in the use of the ICDAS classification protocol.[8]

Within the clinical setting ICDAS classification is only one component of a comprehensive minimally invasive intervention. However, with detailed recording the clinician can use the ICDAS codes to evaluate the effectiveness of preventive measures on caries progression over time. The detection and remineralization of early lesions is cornerstone to the MID intervention. Upon the detection of early lesions, prophylactic measures can be implemented to arrest demineralization and promote remineralization. Furthermore, the identification of risk factors/risk indicators which influence the demineralization and remineralization processes are key to facilitating the effectiveness of such preventive measures. Reducing risk factors becomes an important part of the disease control plan.



### ***Dental Caries Risk Assessment***

The risk assessment approach to disease management is a key component of the MID philosophy and a comprehensive caries management protocol.[9] Dental caries is a dynamic disease of a multifactorial nature; hence, the factors that influence the disease process will vary across the life course. Risk assessment models can be used to determine likely lesion activity, identify high risk individuals/groups and estimate the intensity of treatment to develop an appropriate disease management treatment plans which will establish evidence based appropriate intervals for patient recall.[9-11] Evidence based risk assessment protocols can be used to identify the underlying cause of disease based on (risk indicators – signs of disease, risk factors – biologic predisposing factors including clinical and behavior variables, and protective factors – a variety of clinical, behavioral and therapeutic components). [12, 13]

The current literature has focused heavily on the development of risk assessment models for dental caries among populations of young children and to a lesser extent to root caries among older adults. Past dental caries experience has shown to be the single best predictor of future dental caries experience irrespective of age across various prediction models. Other variables vary in their predictability by the age and population under study. Dental caries risk assessment provides a non-invasive and patient acceptable method to identify high risk individuals/groups to appropriate tailor treatment plans and the allocation of limited resources in community prevention programs.

Information from the use of ICDAS in addition to risk assessment data can be integrated to inform a personalized treatment plan. The International Caries Classification and Management System (ICCMS) is one example of a protocol which integrates tooth level and patient level data to aid patient caries management in both the clinical and public health domains. Individualized patient



centered treatment plans will utilize tooth level and patient level data to guide treatment decisions as well as the frequency of reassessments, future monitoring, additional preventive treatments and patient education.[14]

### ***State of the Evidence***

Early diagnosis, remineralization and risk assessment are not separate technologies mutually exclusive of MID; but rather, part and parcel of the MID philosophy and the development of a comprehensive intervention protocol. Each of these technologies builds upon one another to inform treatment decisions and research hypotheses.

### ***State of the Evidence: Early Diagnosis***

To date there is no accepted “gold standard” for the detection of early carious lesions and there is limited quality data available comparing the reliability of available methods.[15] Standard procedures rely on subjective visual, tactile and radiographic examination, with improved sensitivity and specificity when used in combination but poor when used alone.[15-17] Visually early lesions can be identified by ICDAS codes 1 and 2.[4] Tactile assessment of caries may in fact lead to reduce potential for remineralization and is highly dependent upon the location of the lesion, the probe used and force exerted.[17, 18] While radiography has been the technology of choice for caries detection, it has been shown to have less accuracy than many clinicians believe with more false positives and lower positive predictive values than expected. Accordingly, dental radiography may often underrepresent early demineralization.[16, 19] However, new technologies such as optical aides, fluorescence systems, infrared laser, quantitative light fluorescence (QLF) and LED cameras may provide new technologies for detecting early lesions when used in combination with conventional methods.[15, 16, 20] These methods provide a means to improve



the diagnostic ability to detect lesions at the earliest stages to initiate preventive remineralization treatments.

Few studies have assessed the role of carious disease activity in the detection of early carious lesions.[21] There are currently two diagnostic approaches available to evaluating activity, either monitoring the lesion over time using the ICDAS or evaluating lesion activity during a single examination for which there is no gold standard measurement technology.[21] However, the evidence base is sparse in support of caries activity assessment reliability due to subjectivity of current measurement methods.[21]

### ***State of the Evidence: Remineralization***

The vast majority of data on remineralizing agents have been conducted in vitro, rather than in vivo in human models.[22] While it has been shown that carious lesion, even dentine lesions, can remineralize in vitro discussion ensues regarding the extent of remineralization possible in vivo.[23] Some argue that in vivo remineralization is merely “arrest” of lesion progression. However, others have shown remineralization of lesions over time.[24, 25]

As the definition provided here states that remineralization is the “net gain of calcified material” which had been previously lost to demineralization, the process of remineralization then focuses on fluoride and calcium models. High fluoride tooth paste [26, 27] and high concentration fluoride varnish have been shown to improve remineralization over time.[28-31] Furthermore, more effective antibacterial agents are necessary for high risk individuals, as current remineralization agents alone are not sufficient and currently there are no agents clinically proven to significantly reduce cariogenic bacteria in a clinically meaningful way.[32] To date there are few studies examining the clinical efficacy of calcium models of remineralization.[33]



### ***State of the Evidence: Caries Risk Assessment***

Scientific research supports the effectiveness of preventive strategies based on risk assessment in preventing the initiation, reversal of early caries and preservation of tooth structure.[5] Furthermore, risk assessment based caries management systems have been shown to reduce caries over time compared to non-risk assessment based treatment planning.[34]

Work by Ismail et al. has shown that a significant proportion of caries is ignored when selecting a detection threshold which excludes lesions which are not cavitated.[35] Furthermore, research has shown the utility of assessing caries activity in addition to presence. [36-38] However, research has consistently shown that past caries experience remains the best predictor of future caries risk across age groups.[16, 17]

Among young children (toddlers to preschool) the predictive ability of risk assessment models to correctly classify children using combination of risk factors has generally been shown to be high with sensitivity (SN) and specificity (SP) greater than 0.80.[39, 40] Few studies have evaluated non-cavitated lesions; however, these have repeatedly been shown to be predictive of future dental caries for individuals and may be useful in identifying high risk groups prior to dental caries initiation.[15, 16] Other predictors include mutans streptococci and lactobacillus count in saliva, the presence of visible plaque on the labial surfaces of anterior teeth,[10] dietary factors [41] each with poor diagnostic performance when used as the sole predictor but may improve model performance when used in combination.

Among school aged children and adolescents prior carious lesions are the single best predictor of dental caries risk, with little to no additional benefit in model performance by the inclusion of additional risk factors. [10, 42-45] Parents'





education has additionally been shown to increase predictability in some studies. [46, 47] The literature clearly highlights limitations in generalizability of risk assessment models and the need for population specific risk factor models. Furthermore, in the permanent teeth, risk of developing a carious lesion is highest immediately following eruption, [10] which calls for the use of prevention to protect teeth vulnerable to decay. [48, 49]

Studies among adults have focused on evaluating risk of root caries among older adults.[40] Indicators of past dental caries experience remain the strongest predictors of risk of dental caries among older adult populations, irrespective of additional predictors.[40] There have been no reported studies evaluating dental caries risk assessment in young adults.

The MID approach to caries prevention and control is gaining increasing support. The FDI World Dental Federation, building on its year 2000 policy, published a policy statement on the classification of caries lesions and caries management systems in 2013 (50), endorsing a move to the MID approach and the use of caries management systems outlined above. The FDI recommends the “implementation of existing, continuing and future research activities to improve the systems and their delivery be a priority”. [50] The implementation of the ICDAS Foundation’s International Caries Classification and Management System (ICCMS™) has now been taken forward more systematically by the formation of a Global Collaboratory for Caries Management (GCCM) launched at King’s College London in June 2013 specifically to advance the implementation of ICCMS™ in Practice and Education.[51] Although there is an increasing enthusiasm for the adoption of this Minimally Invasive (MI) approach, there is also a realization that “Minimum Intervention is concerned with preventing disease rather than restoring teeth and attitudes towards remuneration and



financial rewards for restorative operative intervention need to be addressed if dentistry is to reflect these new ideas of best practice”. [52]

## **Summary**

MID has developed over the past 20 or more years as a combination of technologies that aim to utilize preventive measures to preserve natural tooth structures. MID applies the logic and process of risk assessment as well as the technologies involved in early diagnosis, remineralization and a variety of newly developed and developing restorative treatment technologies.

As the science base for each of these technologies has improved, MID becomes adopted by increasing numbers of clinicians and dental school curriculum committees globally. The science for MID is advancing thus enabling dental care providers to conserve increasing amounts of the natural dentition with a goal toward maintaining the entire natural dentition for the full life span.



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