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"SETTING THE SCENE IN EARLY CHILDHOOD" – AN MID APPROACH FOR LIFE

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Abstract

This article presents a discussion paper for both consideration and implementation of Minimal Intervention Dentistry (MID) principles by the general dental practitioner. It argues that if these concepts can be adopted in early childhood by both the community and the profession, "Teeth for Life" can become a reality for all. Oral Health promoting behaviours can be nurtured and supported from infancy and developed into everyday living practice for a lifetime thereby maintaining an optimal quality of life. MID techniques have become more refined and supported by scientific research in the recent times and should be considered an essential clinical guideline for the future disease management.

Introduction

The concept of Minimal Intervention/Invasive Dentistry (MID) has been advocated for more than 25 years as an approach that promotes the preservation of an unadulterated natural dentition for life. However, this concept, to this day, is not well understood and not practised by the majority of the dental profession, and most definitely not considered at all by the general public (consumers/patients) due to total lack of awareness of this approach to the management of dental disease. This concept focuses on developing a partnership between the dental professional and the patient to address and manage risks behaviours that promote oral disease.

MID has been promoted in the past for the management of dental caries, however, the concept is equally feasible for the management of all chronic oral conditions, and in particular dental caries and periodontal disease. It promotes early identification of risk factors, early identification of signs of the disease, early interventions (actions by both the clinician and the patient) to promote reversal (healing) of the early lesions and, where it is appropriate, use minimally invasive restorative techniques to help restore the teeth affected with more advanced lesions to a functional dentition.

The term ‘minimally invasive restorative techniques’ is, mostly, misunderstood by the dental profession. This statement is generally related to the management of dental caries and understood to mean ‘preparation of small cavities in teeth and restoring them with biomimetic restorative materials’. This interpretation is limited to situations where the use of small cavity preparations and the use of biomimetic materials will ensure the preservation of the natural tooth affected for life. However, biomimetic materials have their limitations. They are extremely technique sensitive (this impacts on their ability to provide a hermetic seal) and their compressive and tensile strength are inadequate. If used in inappropriate situations, these restorations, although minimally invasive, are more likely to fail and need to be replaced on numerous occasions, resulting in greater loss of tooth structure and the need for more complex restorations over the life span of that tooth. On the other hand, a restorative technique that is less technique sensitive (and therefore more likely to provide a hermetic seal) and requires, initially, more extensive removal of tooth structure, but is known, through evidence, to be long lasting and protective of the remaining tooth structure (e.g. a stainless steel crown/cast crown) would actually be considered as more minimally invasive than the former technique mentioned above. Furthermore, evidence suggests demineralised dentine, under a restorative material which provides a hermetic seal from the oral environment, will remineralise. This is mainly due to a decrease in the cariogenic potential of the biofilm that is isolated from the oral environment, supporting the view that the ‘the seal is the deal’. So the focus, should be on providing a restorative (or other) technique that will protect and preserve the affected tooth for as long as possible, if not for the life of the tooth affected.

The goal of the MID concept is to avoid the need for dental treatment (restorations or other dental treatment) in the first place. Identification of risk factors to oral disease, prevention of dental disease and identification of early lesions are critical elements of the MID approach and are paramount for the avoidance of treatments that will adulterate and more likely promote ongoing treatments and maintenance of the affected tooth and its supporting structures. Identifications of modifiable risk behaviours early is essential to assist parents/carers and individuals to consider, where possible, reducing or eliminating these modifiable risk behaviours.

Current oral disease risk assessment tools are not adequate in determining future oral disease development in individuals who do not show any signs of the condition. Many of the current risk assessment tools rely on the presence of the disease to determine the risk for future disease. Conversely, patients who have no previous oral disease experience may be deemed to be at low risk to the dental disease, when in fact their risk status could be changing from low to high risk due to recent unidentified lifestyle changes leading to more risky health behaviours.

As mentioned, the prevention of dental disease involves a partnership between the oral health professional, who provide preventive professional care, and the patient/community for the implementation of self-management of the condition through appropriate home care and community level preventive strategies.

Preventive professional care involves the development of individualised preventive strategies for each patient that includes: professional care (topical fluoride gels & varnishes, fissure sealants, plaque assessment, saliva testing, radiographic assessment, minimally invasive restorations; and regular maintenance of tooth supporting structures); home care (oral hygiene practices, diet modifications and use of oral health care products), and regular individualised review/recall visits.

Fluoride exposure, in the form of community water fluoridation, professional applications, and as a component of home oral health care products, is considered key to the prevention of dental caries. Regular topical fluoride applications to teeth (at the appropriate dose) favours remineralisation of early carious lesions. The crystalline structure of the enamel that has been exposed to fluoride during its development (Fluor apatite Crystals) is more resistant to acid dissolution (i.e. the critical pH for enamel dissolution drops from 5.5 to 4.5). In our modern world, this is not hard to achieve when most of our carbonated sweetened beverages are at pH level well below 4.5. Oral Health professionals need to be aware that enamel frequently exposed to fluoride at the appropriate dose can still demineralise if exposed frequently to an acidic environment that is constantly below a pH level of 4.5.

When promoting oral hygiene practices and healthy diet behaviours, professionals should be cognisant of the broader social and cultural practices beyond the control of the individual patient that impact on the oral health behaviours of these individuals. These broader social and cultural practices include: unaffordable oral health products; misleading marketing of 'sugar containing highly processed' foods as 'healthy'; unaffordable healthy food alternatives; the belief by some cultures that tap water is unsafe to drink; and the lack of regular access to preventive and affordable dental services. These social and cultural practices indirectly affect individuals' health decisions and behaviours. As oral health practitioners, it is our role to increase the awareness of our patients and local community groups regarding the adverse oral health impacts of these broader social and cultural practices.

Currently there is no convincing evidence linking an individual's oral disease risk status and the length of time between review/recall appointments. The current recommendation is that the length of time between recall appointments should be individualised and based on the results of the data collected during regular comprehensive dental examinations of the patient involved, with the aim to increase the length of time between recall appointments as the patient's risk status changes from high risk to medium and low risk.

Principles of Minimal Intervention Dentistry (MID)

Based on the FDI systematic review in 2012[1], the 5 strategies or principles of MID are as follows:

1) Early caries detection and risk assessment
2) Remineralisation of demineralised enamel and dentine
3) Optimal caries preventive measures
4) Minimally invasive operative interventions
5) Repair rather than replacement of restorations[1]

It is important to note that application of MID principles does not equate to the cutting of smaller cavity preparations, but is a philosophy that aims to manage caries as a biological disease process rather than a tooth cavity.[1] In fact, the first three principles of MID should be practiced and maintained throughout life. Surgical interventions should only be employed when oral health maintenance has failed and a cavity has developed.[1] However, if the carious lesion is quite extensive, it is not against MID principles to adopt a more surgically aggressive approach and restore the tooth with a full coverage restoration, such as a stainless steel crown, in order to achieve a hermetically sealed lesion and ensure longevity of the tooth.

Early caries detection & risk assessment

Early caries detection involves the use of detection devices and visual-tactile methods.[1] Detection devices include radiography techniques, fibre-optic trans-illumination (FOTI), infrared laser fluorescence devices (DIAGNOdent), qualitative light-induced fluorescence (QLF, Sopralife), and electrical impedance (CarieScan PRO, photothermal radiometry (Canary System).[1] To date, radiography for the purpose of detecting carious lesions in teeth is still the oldest and most reliable caries detection device apart from the blunt dental probe.[1] It is sensitive for detecting approximal carious lesions but is less so for detecting occlusal carious lesions especially those in enamel and the outer half of dentine.[1-3] Other than FOTI devices which are sensitive in detecting approximal carious lesions, especially in anterior teeth, the detection devices listed above have their own limitations and at best should be considered an adjunct to the more reliable methods such as radiography and visual-tactile examination.[1, 4]

Visual-tactile records include epidemiological indices such as the International Caries Detection and Assessment System (ICDAS), Nyvad-index, the ‘Pulpal Involvement Ulcerations Fistula Abscess’ (PUFA) index and Caries Assessment Spectrum and Treatment (CAST).[1, 5]

Caries risk assessment (CRA) is assessment of the 'probability of future caries disease development' which includes development of primary disease (new carious lesions) and secondary disease (lesion progression or reactivated lesions).[1] Unfortunately, most CRA tools to date rely on the presence of disease to determine the risk of future disease. CRA aims to provide an individual or population-based treatment approach according to caries risk in the hope of determining the most appropriate management decision for an individual patient.[1] Different systems for assessing caries risk are available such as the 'Caries Management by Risk Assessment' (CAMBRA), the Cariogram, and International Caries Classification and Management System (ICCMS).[1, 6, 7]

Although it is well established that 'past and present caries experience', especially the presence of active carious lesions, is the strongest predictor of future caries experience, it is important to bear in mind that caries risk is dynamic and changes over time according to the patient's risk factors.[1, 8, 9] Past caries experience is the effect of a biological disease and not the cause of it, thus, risk assessment loses its predictive ability if previous interventions have been successfully implemented and identified risk factors have been removed.[7, 10] For example, patients who have changed certain dietary and hygiene habits to improve and maintain good oral health may be deemed at low caries risk despite having had multiple restorations placed previously. Conversely, patients who have had no previous carious experience may be deemed to be low caries risk, when they could be high caries risk due to recent changes to dietary and oral hygiene habits.

Remineralisation of demineralised enamel and dentine

Dental caries is a multifactorial disease of teeth, brought about by the ever-present and natural phenomena of bacterial metabolism in the dental biofilm.[11, 12] It is a multifactorial interplay between various environmental, behavioural and genetic factors.[1, 13] However, caries initiation and progression is influenced by six main factors: composition and amount of plaque, dietary sugar consumption frequency and timing, fluoride exposure, salivary flow and composition, enamel quality and individual immune response.[1, 11, 12] The continual process of bacterial metabolism in the dental biofilm causes constant pH changes which result in cycles of mineral loss (demineralisation) and gain (remineralisation) in adjacent tooth structure. The carious process is clinically manifested in the form of a carious lesion only when there is a net loss of mineral from the tooth.[1, 11] Thus, an individual with teeth can never be "free from the dental caries" process.[1, 11]

Dental caries describes both the carious process and the carious lesion, which is a manifestation of the biological process.[11] It is important to distinguish between the two as the lesion is the inevitable consequence of the process, which is reversible in its early stages and can be halted at any time, thus making it preventable.[12] Consequently, the disease must not just be managed surgically at the tooth level, but rather as a process, as advocated by the principles of MID. Remineralising agents which favour mineral gain in tooth structure are thus of paramount importance to prevent progression of the carious process.

Fluoride

The role of fluoride in controlling caries has been widely established. Research has proven repeatedly that fluoride promotes remineralisation and inhibits demineralisation of tooth structure.[14, 15] The main effect of fluoride in preventing dental caries occurs locally at the tooth-plaque interface where enamel is exposed to ionic fluoride, forming Fluor apatite in the presence of calcium and phosphate made available during the demineralisation process by plaque bacterial organic acids.[15-18] Fluoride decreases the solubility of enamel, which is achieved by two means: 1) the formation of a less soluble crystalline structure as the fluoride ion in the crystal lattice is more stable than the hydrogen ion, and 2) fluoride ions interact closely to bind strongly with calcium ions on the crystal surface.[1, 16, 19] The low solubility of Fluor apatite also increases the precipitation rate of enamel mineral in the presence of calcium and phosphate, favouring remineralisation over demineralisation.[1, 16] Thus, not only is mineral loss reduced in an acid challenge, but the Fluor apatite-like crystalline structure formed in the tooth is more resistant to subsequent acid attacks.[15, 20] This process occurs regardless of form or concentration of topical fluoride used, however, a higher concentration of topical fluoride results in the precipitation of calcium fluoride at the enamel surface and plaque acts as a reservoir for fluoride ions for subsurface lesion remineralisation.[15, 20] A longer application of low concentration topical fluoride is adequate to exhibit the beneficial effects of fluoride.[20]

At higher concentrations, similar to that of topical fluoride applications, fluoride has also been shown to affect bacterial metabolism in dental plaque, reducing carcinogenicity of the dental plaque.[21, 22] Penetration of topical fluoride into dental plaque has been shown to be proportionally related to the duration of exposure to fluoride.[1, 23] Watson et al. demonstrated that a 120-second exposure to 1000ppm of fluoride resulted in a higher fluoride concentration in plaque compared to a 30-second exposure.[23] This finding may influence advice on tooth brushing duration to be at least 2 minutes rather than 30 seconds. A widely accepted recommendation is that brushing at least twice a day with fluoride toothpaste is appropriate for all age and risk groups.[24]

There are a number of ways fluoride can be provided to the tooth surface: via water, milk, salt, consumer products such as infant formulas and beverages, professional administration, and through self-application devices which include toothpastes, gels, varnishes and mouthwashes.[1] Despite the availability of products containing fluoride, water fluoridation is still considered the most effective population-level strategy for preventing dental caries with demonstrated safety, efficacy and low cost.[25, 26] The benefits of water fluoridation have also been found to continue into adulthood and extend to non-fluoridated communities.[25] Based on a nationally representative examination survey and a more recent study on the caries-preventive effectiveness of water fluoridation in adults in Australia, it has been found that adults with a greater lifetime exposure to water fluoridation had lower levels of caries experience, including those in rural communities.[27, 28] Furthermore, the beneficial effect of fluoride on caries prevention was found to be as great in adults born before widespread implementation of fluoridation as compared to after the widespread implementation of fluoridation.[28] This confirms the effects of fluoride to be mainly post-eruptive by the mechanisms discussed above, rather than pre-eruptive as previously thought.[13]

Other modalities of topical fluoride have shown less consistent results in their efficacy on caries prevention. This is mainly due to the quality of evidence which is moderate at best.[15, 29] Despite the lack of high quality evidence, Marinho et al. in a recent Cochrane review give a strong recommendation for prescription of topical fluorides for caries reduction.[29] They found that fluoride varnishes applied twice yearly have shown to reduce caries increment most significantly in both permanent and primary dentitions with a 43% and 37% reduction in caries increment respectively, when compared to data available on fluoride toothpastes (24%), mouth rinses (26%) and gels (28%). In addition, they found that topically applied fluoride reduces dental caries progression regardless of exposure to fluoride by other means such as water fluoridation. Fluoridated toothpaste has also been found as protective against dental caries progression when compared with other topically applied fluoride interventions, although simultaneous use of other topical fluoride treatment resulted in greater reduction in dental caries. The caries preventive effect of fluoridated toothpastes was also found to be increased with fluoride concentration above 1000ppm. Similarly, fluoridated milk has been shown to have some beneficial effect on caries prevention in school children. In contrast, slow-release fluoride glass beads show weak evidence for caries prevention effects. With regard to concerns about dental fluorosis, evidence linking topical fluoride use and fluorosis was weak, however, toothpastes with more than 1000ppm have been associated with an increase in fluorosis when used inappropriately.[29]

In a recent Cochrane review, moderate quality of evidence was found to suggest that the application of fluoride gels either professionally- or self-applied, is associated with a large reduction in caries increment in permanent teeth in children.[15] However, there is limited research on the potential unwanted or harmful effects of ingesting fluoride during treatment with fluoride gels, which warrant more research.[15] In cases where there is risk for dental fluorosis such as in young children, a low-strength fluoridated toothpaste (<1000ppm) is recommended.[1, 30]

CPP-ACP & CPP-ACFP

Both calcium and phosphate ions are necessary for remineralisation to occur. The availability of these ions therefore, limits the remineralisation potential of dental enamel, especially during the application of topical fluoride where the formation of Fluor apatite is concerned.[17, 31] Previously, calcium and phosphate ions were clinically unsuccessful in producing remineralisation due to the low solubility of calcium phosphates in the presence of fluoride ions.[17] This has led to the development of different products which aim to provide calcium phosphate-based remineralisation systems. Casein phosphopeptide-stabilised amorphous calcium phosphate (CPP-ACP) is one such product which has been shown to provide high concentrations of bioavailable calcium and phosphate ions in the presence of fluoride ions.[17] Casein phosphopeptide binds with calcium to form nanoclusters of amorphous calcium phosphate, thus 'stabilising' calcium and phosphate in a bioavailable form at the tooth surface.[17] Casein is a milk-derived protein naturally found in milk which stabilises calcium and phosphate ions, similar to statherin and acidic proline-rich proteins naturally found in saliva.[32] Saliva and milk have limited remineralisation potential on their own, such as in cases of xerostomia or hyposalivation. Thus, extrinsic sources of calcium, phosphate and fluoride ions would be required to augment the remineralisation potential of saliva.[32]

To date, considerable in vitro research has been done on CPP-ACP and it has been shown to inhibit enamel demineralisation and enhance remineralisation of enamel.[17, 33] CPP-ACP with fluoride (CPP-ACFP) also exhibits similar anticariogenic properties and has been shown to remineralise white spot lesions both in vitro and clinical trials with CPP-ACFP showing greater remineralisation potential than CPP-ACP.[31] Importantly, both CPP-ACP and CPP-ACFP induce remineralisation of the enamel subsurface lesions extending through the whole depth of the lesion.[31] CPP-ACFP has been recommended for use in children over 10 years of age due to the added fluoride content.[33] CPP-ACP has been successfully incorporated into sugar-free gum, toothpaste and confectionary.[34] One study showed that the incorporation of CPP-ACP into chewing gum promoted higher levels of remineralisation compared with a sugar-free gum without CPP-ACP or no-gum control.[35] This conclusion was supported by the findings from another study of CPP-ACP in sugar-free gum where it was shown to significantly slow caries progression and enhance caries arrest compared with sugar-free gum alone.[36, 37]

Optimal Caries Preventive Measures

The best strategy for managing dental caries is prevention.[1] Different measures are available to achieve this purpose; it is the dental clinician's task to choose the most appropriate preventive measure for each individual and clinical situation based on the patient's risk profile, which may include more than one preventive measure at times.[1] These measures include:

Diet Counselling & Sugar Substitutes

There is evidence that rather than being a multifactorial, infectious disease, caries is a diet-mediated disease which requires a single specific cause: free sugars for bacterial metabolism.[38] Free sugars are the necessary dietary cause of caries, with other factors such as oral microorganisms, differential enamel properties of different teeth, salivary flow, the role of fluoride and the frequency of consumption of specific carbohydrates simply modifying the speed of the cariogenic process.[38] Despite the availability of fluoride in toothpastes and water which have contributed to the decline of caries in children, the prevalence of caries continues to increase with age, becoming more prominent in older populations.[28, 38, 39] This conclusion is supported by the findings of a recent systematic review which showed the life-long causal relationship between free sugars and dental caries, with caries progressing throughout life.[40] Thus, it has become increasingly apparent that there exists a positive log-linear dose-response relationship between free sugars intake and dental caries.[38] Based on an analysis of cohort studies which confirm these findings and show higher caries incidence where sugar intake is more than 10% of total energy intake, the World Health Organisation has made the following recommendations in 2015:

"WHO recommends a reduced intake of free sugars throughout the life course (strong recommendation). In both adults and children, WHO recommends reducing the intake of free sugars to less than 10% of total energy intake (strong recommendation). WHO suggests a further reduction of the intake of free sugars to below 5% of total energy intake (conditional recommendation)."[41]

The causal relationship between dietary sugars and dental caries is well established, despite becoming weaker since widespread exposure to fluoride became available.[42] Hence, diet counselling is still an important part of any prevention program.[1] The frequency of dietary sugars appears to be an important factor in the development of dental caries and cariogenic foods should be restricted to mealtimes.[43-45]

Dietary control measures have most benefit to children at high caries risk, while offering less benefit to those considered at low risk with adequate saliva, optimal exposure to fluoride and who practice adequate oral hygiene measures.[1, 42]

Sugar substitutes have emerged as a way to reduce exposure to dietary sugars, with the aim to reduce caries risk. The main sugar substitutes used in "sugar-free" foods are the polyol sweeteners such as xylitol, sorbitol, and mannitol; the most researched being xylitol.[46] The use of xylitol for the purpose of reducing caries risk, however, remains controversial.[47] There is some evidence that xylitol may reduce caries: as a substitution of cariogenic free sugars, a saliva stimulant and having a possible active anti-caries effect against S. mutans.[46-48] When used in combination with fluoridated toothpastes, xylitol appears to have a synergistic effect with fluoride in reducing caries, although the evidence is reportedly of low quality.[47, 49] Xylitol has also been successfully added to a variety of foods and products such as gummy bears, macarons, candies, chewing gums, mints, syrups, lozenges and mouth rinses.[48] However, according to a recent Cochrane review, there is insufficient and low to very low quality of evidence to determine the anti-caries preventive effect of xylitol-containing products (other than xylitol-containing fluoride toothpastes) in infants, older children or adults due to the limited number of available studies, uncertain results and study protocol differences.[47] The anti-caries effect of xylitol is dose-dependent and frequency dependent, and if consumed in excess, has been known to cause gastrointestinal side effects such as bloating and diarrhoea.[46, 48] In addition, there is potential for dental erosion if used in combination with acidic flavouring agents.[50]

Chlorhexidine

Chlorhexidine has been studied as a potential therapeutic agent against dental caries due to its ability to supress S. mutans.[51] It is available in many forms (mouth rinse, gel, varnish, toothpaste) with varying concentrations.[51] To date, research available on its anti-caries effects is inconclusive and generally lacking statistical significance.[1, 51, 52] A recent Cochrane review was unable to find strong evidence to support the use of chlorhexidine in the prevention of caries or the reduction of Mutans streptococci levels in children and adolescents.[53] A previous systematic review by Zhang et al. showed moderate caries inhibition when a chlorhexidine varnish was applied every 3-4 months, with effects diminishing with longer intervals and 2 years after the last application.[51, 54] Due to its short-term effects, it is suggested that chlorhexidine varnish be used only as a short term option for caries control in individuals at high caries risk with high bacterial counts.[1]

Silver Diamine Fluoride (SDF)

SDF is a combination of silver nitrate and sodium fluoride which on application, interacts with bacteria to inhibit caries progression.[1, 55] It has been used topically to arrest caries since the 1900s with a concentration of 38% being the most widely used and studied in clinical trials.[56, 57] A lower concentration of 12% has been found to be less effective in arresting caries in children.[57] An in-vitro study showed the ability of 38% SDF to inhibit multi-species biofilm formation on carious dentine lesions and to reduce dentine demineralisation.[58] Clinically, SDF appears to be effective in arresting caries in the primary dentition, permanent first molars and root surface caries.[57, 59] In regards to frequency of application, some authors have recommended a six-monthly application for effective caries prevention.[57] To date, evidence supporting the efficacy of SDF in caries management is weak and more research is needed to validate its role in caries prevention.[1, 56] Its role in the management of cavitated lesions will be discussed later.

Pit and Fissure Sealants

By nature of their morphology, the pits and fissures of permanent molar teeth make them particularly susceptible to caries development during and after tooth eruption.[1] Thus, sealing the pits and fissures of these teeth in particular should serve as a preventive measure against caries initiation and has been shown to effectively arrest non-cavitated enamel carious lesions in these sites.[60] The two main materials used are resin–based materials and glass ionomer cements (GICs), however, which material is more effective at preventing caries progression still remains unclear.[61, 62] Pit and fissure sealing appears to be more effective at preventing caries progression compared to non-invasive treatment alone such as fluoride varnish, although the need for retreatment may be higher.[62, 63] With the advent of the atraumatic restorative technique (ART), high-viscosity GICs have been used as sealants and found to have a high caries protective effect with improved retention rates compared with medium- and low-viscosity GICs, but less so than resin-based sealants.[61] Glass ionomer cements appear to have a protective effect even when not clinically visible.[64, 65] Due to the extensive evidence supporting the efficacy of sealants preventing pit and fissure caries initiation, fissure sealants should be recommended in all patients with at-risk tooth surfaces.[1]

Minimally invasive operative interventions

The principle of MID in managing a cavitated tooth is "to remove decomposed (infected) dentine and leave demineralised (affected) dentine behind, and to restore the cleaned cavity with a restorative material that has optimum biological and physical properties."[1] Applying this principle naturally requires a minimally invasive cavity preparation. A cavitated surface should be restored as it retains plaque which encourages the progression of caries, thus filling the cavity will aid in plaque control as well as restoring form, function and aesthetics of the tooth.[1] There is evidence to support the remineralisation of demineralised dentine under a restorative material which is well-sealed, mainly due to a decrease in cariogenic potential of the biofilm left behind, supporting the view 'the seal is the deal'.[1, 66, 67] This ideology has led to a shift in restorative techniques from that of 'extension for prevention' to 'prevention of extension', in keeping with the principles of MID.[1] To achieve this, various adjunctive measures have been recommended:

Alternative Restorative Therapy

Atraumatic Restorative Treatment (ART)

This technique was introduced about 25 years ago to allow management of dental caries in basic care-deprived communities.[61, 68] It has since evolved to consist of two treatment modalities: restoration of tooth cavities with sealant-restorations (ART restorations) and sealing of caries-prone pit and fissure systems (ART sealants).[61, 68] Initially using polycarboxylate cements, ART currently employs the use of GICs to seal pits and fissures and restore occlusal cavities into dentine.[68] Hand instrumentation is used to gain just enough access into the carious lesion to allow removal of decomposed carious dentine.[68] The cavity is then cleaned, conditioned and dried, followed by restoration with a high-viscosity GIC using finger pressure.[61, 68] This therapy adheres to the principles of MID by producing a minimally invasive cavity preparation through removal of decomposed dentine by hand instrumentation only. The fact that ART requires no electrically driven instruments, running water or administration of local anaesthesia, makes it not only suitable for use in communities with limited facilities, but also be more widely accepted by adults and children alike.[1, 69]

Current evidence shows favourable results for ART. When compared with conventional amalgam restorations, ART restorations have shown promising survival rates, with one meta-analysis reporting no difference between the two restorations over a three-year period for single-surfaced restorations in permanent teeth.[70] Another systematic review reported no significant differences between ART restorations and amalgam in the primary dentition over a two-year period, while in the permanent dentition, ART restorations appeared to have equal or greater longevity than that of amalgam restorations for up to 6.3 years.[71] In a more recent meta-analysis, it was reported that the cumulative survival rates for single-surface and multiple-surface ART restorations in primary teeth over the first two years were 93% and 62% respectively, whereas in the permanent dentition, survival rates for single-surface ART restorations over the first three and five years were 85% and 80% respectively.[72] The longevity of multiple-surface ART restorations was slightly lower at 86% after one year with an annual failure rate of 17% reported.[72, 73] Due to different assessment criteria which are less stringent for ART, survival rates for ART sealants and restorations could be underestimated and in reality may be at par with other more conventional restorations.[1, 68] Further research is needed to confirm this possibility.[68]

With regard to caries prevention, ART sealants appear to show very promising results.[68] A mean annual cavitated dentine lesion incidence rate in pits and fissures previously sealed with ART sealants show a low rate of 1% over the first three years.[72] In addition, although previously reported to be low, retention rates of ART sealants have dramatically improved with the use of high-viscosity GICs.[72, 73] A recent study reported a two-year retention rate of 78% compared with 86% for resin-based sealants, which is similar to that reported in a meta-analysis by van't Hof et al. showing an 82% retention rate.[73, 74] It has subsequently been recommended to use high-viscosity GICs (e.g. Ketac Molar) for ART sealants instead of medium-low viscosity GICs.[72]

Based on a comprehensive review by Frencken et al. in 2012, it was concluded that ART sealants have a high caries preventive effect and ART restorations can be safely used in single-surface cavities in both primary and permanent posterior teeth.[68] However, there is insufficient information to support the use of ART restorations in cavities with multiple surfaces.[68]

Hall technique

This technique was first introduced in 2006, for the management of caries in primary molars based on the MID principles of conservation of tooth structure.[75] It uses stainless steel crowns to seal dental decay (decomposed dentine) in deciduous molars and, also for the management of hypomineralised primary molars. It involves providing a hermetic seal by cementing the crown onto the tooth with Glass Ionomer Cement, without the use of local anaesthesia, caries removal, or crown reduction. This technique is not an easy, quick fix solution to the problem of the carious primary molar. It requires careful case selection, high level of clinical judgement, and good patient management techniques.

Indications for use of the Hall Technique include: small to moderate carious lesions (cavitated or non-cavitated) and not extending beyond the middle third of dentine (or where a 'clear band of sound dentine' can be seen on a radiograph between the advancing front of the carious lesion and the coronal pulp).[76, 77]

Contraindications include primary teeth with: dental caries that extends beyond the middle third of dentine (or no 'clear band of dentine' can be seen on a radiograph between the advancing front of the carious lesion and the coronal pulp); signs or symptoms of irreversible pulpitis, or dental sepsis; clinical or radiographic signs of pulpal exposure, or periradicular pathology; crowns so broken down that they would normally be considered as un-restorable with conventional restorative techniques.[76, 77]

This technique has been shown to be well accepted by children due its minimally invasive nature, and appears to be similarly acceptable to parents and clinicians alike.[76, 78, 79] A five-year practice-based study showed that Hall technique restorations performed better than conventional restorations using plastic materials in primary teeth.[77] A recent retrospective study has reported high survival rates of Hall technique crowns (97%) when compared with conventional crowns (94%) placed over a 10-year period, with most failures occurring within the first 2 years.[80] As the Hall technique does not require tooth crown reduction, an increase in the patient's occlusal vertical dimension of about 1.5-2.00mm occurs following cementation of the crown. Current evidence indicates that the child's occlusal vertical dimension (OVD) is fully re-established with 2-4 weeks after cementation of the Hall Crown. Children have demonstrated very little discomfort as a result of this temporary increase in OVD.[76, 81] A recent Cochrane review concluded that there is still insufficient evidence to determine if Hall technique crowns can be recommended over conventional stainless steel crowns, although Hall technique crowns may reduce discomfort at the time of treatment when compared with conventional crowns.[82]

The Hall technique efficacy has been shown by randomised control trials and is well accepted by clinicians.[76] The Hall technique makes it overall easier for the child (and parent) to cope with restorative treatment, as it does not require local anaesthesia or tooth preparation. It is very quick to complete (from crown selection to cementing of the crown it has been shown to take on average less than six minutes to place, and is easy to teach to students and clinicians alike.[81]

Richard Welbury (2017), in his reflection on 'Ten years since the introduction of the Hall Technique in the UK' concluded that: "The Hall Technique has made a huge difference to children, parents and clinicians in the management of caries in the primary dentition. It has given us a biological solution to a significant national and international problem".[83]

Stepwise excavation & indirect pulp capping

As previously discussed, evidence to support the sealing in of caries to allow arrest of the dentinal carious lesion is extensive, which suggests that complete caries removal is not necessary to arrest caries progression.[67] This ideology has led to the development of caries management strategies in deep lesions based on partial or no caries removal, as compared with conventional restorative strategies where complete caries removal was advocated.[67] Two of these strategies are the stepwise excavation and indirect pulp capping. Both strategies involve partial caries removal with peripheral caries clearance from the enamel-dentine junction. In indirect pulp capping, decomposed dentine is left behind and is covered by a lining material followed by a well-sealed permanent restoration, whereas, in stepwise excavation, an interim restoration is placed for a period of time, after which the cavity is re-entered and complete caries removal is undertaken followed by a permanent restoration.[84] The main basis for these strategies is to prevent iatrogenic pulpal exposure during complete caries removal.[67, 84] Both strategies appear to be more protective against pulpal exposure when compared with traditional complete caries removal.[85] Based on available research, the debate is currently whether caries should be left behind in the tooth definitively or be completely removed after a period of time. In the primary dentition where the lifespan of a tooth is finite, there is probably less need for a second procedure as long as caries progression is arrested.[86]

Despite a lack of good quality, long-term studies to support one strategy above the other, results appear to support the use of indirect pulp capping over stepwise excavation in both primary and permanent dentitions.[67, 84, 87] One study has reported a higher success rate for indirect pulp capping (99%) compared with stepwise excavation (86%) over a period of 18 months.[88] In terms of cost, indirect pulp capping is more cost-efficient not only from a biological aspect, but also in terms of operating time and financial costs.[88, 89] Indirect pulp capping took 39% less time to complete than stepwise excavation thereby avoiding the need for a second operative procedure.[88] In another study, indirect pulp capping showed good success rates in both primary and permanent dentitions with a 96% success rate in primary teeth and 93% success rate in permanent teeth.[87] Long term results of indirect pulp capping in primary teeth also appear favourable with a 88-93% success rate over a period of 4 years.[86] That being said, more research is needed to validate one strategy over the other.

Repair rather than replacement of restorations

Restorations have a finite lifespan in the oral cavity, thus failure of restorations should be expected in general dental practice. In reality, more than 50% of general dental practice work consists of the replacement of restorations.[90, 91] More often than not, restorations are replaced rather than repaired if assessed to be defective or subjected to secondary caries, especially if assessed by an operator different to the operator who placed the restoration.[92] The clinical diagnosis of secondary caries is the main reason for restoration replacement, however, it should be noted that assessment of secondary caries is challenging and it is often difficult for clinicians to differentiate between secondary caries and marginal staining, especially without clear objective criteria.[92, 93] Despite evidence to show that marginal leakage below 400µm in a restoration bears no consequence on secondary caries development, most clinicians choose replacement of restorations over more conservative treatments such as repair.[94]

Replacement of a restoration should only be undertaken after careful consideration as the removal of an existing restoration has been shown to inevitably remove significantly healthier tooth structure.[95] This in turn results in a larger and possibly more complex restoration, and may cause additional stresses on the tooth, pulpal reaction, and possible damage to adjacent teeth, and ultimately affect longevity of future restorations and lifespan of the tooth.[1, 96] Whenever possible, clinicians should always choose to repair a restoration rather than replace it.[1, 97] This may involve measures such as polishing or sealing the affected area and removal of the affected area followed by re-restoration of that area only.[1] A general rule is to replace a restoration only if the defective areas cannot be managed without complete removal of the restoration, or if pulpal symptoms are present.[1]

Research has shown that repair of restorations instead of replacement is a successful treatment option which is more cost effective in regards to time and operational costs, and is associated with less patient anxiety.[97] This is evidenced by a few longitudinal cohort studies which show repaired restorations having the same or even increased longevity compared to replacement restorations.[98-100] One randomised controlled trial showed positive results for repaired vs replaced amalgam restorations with similar survival outcomes after 10 years.[101]

Importantly, the decision on whether or not to repair or replace a restoration should not be based solely on clinical and radiographic examination, but more so on the patient's past dental history and current caries risk status.[1, 102]

Conclusion

MID offers a holistic philosophy to oral disease management with greater emphasis on prevention, followed by the preservation of the natural dentition, wherever possible. It is important that both clinician and patient understand that oral diseases can only be managed through the development of a partnership between the dental professional and the patient to address the risks behaviours that promote oral disease. This mutual understanding is crucial to the long term success of an MID philosophy applied in general dental practice.

To achieve the goal of teeth for life using an MID approach, it is recommended that:

1. A community based Oral Health Promotion Strategy focused on the "Minimal Intervention Dentistry philosophy" be developed, implemented and evaluated with the aim of increasing community (both professionals groups and the general public) understanding of the importance of preventing oral disease, through early identification of the disease and associated risk factors, in order to eschew surgical solutions for management.

2. The community (both professionals groups and the general public) be made aware that enamel frequently exposed to fluoride can still demineralise and become carious, if exposed frequently to beverages with a pH level below 4.5. The need for change in current dietary practice remains paramount for the longevity of the dentition.

3. As oral health professionals, it is our role to increase public awareness regarding the negative impacts of the broader social and cultural practices that influence an individual's oral health behaviour.

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