Minimally invasive cosmetic dentistry: When less is more!

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_**Minimally invasive dentistry (MiD)**, also known as minimal intervention dentistry and preservative dentistry, is a practice mindset and philosophy. There is no escape from MiD in clinical practice. All clinicians practice MiD periodically whether consciously or unconsciously. As a practice philosophy, there are principles of being, knowledge and/or conduct.

Although MiD relates to most oral diseases and aspects of dentistry, its application to caries is probably the most evolved. Carious lesions that are demineralised and non-cavitated are now "healed" instead of surgically removed. Tyas *et al.*[1], as part of a FDI Commission-initiated project, provided an overview of the principles and concepts of MiD, suggested techniques and presented the results of clinical studies as they pertain to dental caries. The principles of MiD in relation to caries management are:

_remineralisation of early lesions;
_reduction in cariogenic bacteria, in order to eliminate the risk of future demineralisation and cavitation;
_minimum surgical intervention of cavitated lesions;
_repair rather than replacement of defective restorations; and
_disease control.

Based on these foundational tenets, generic MiD principles can be proposed for all oral diseases. They are:

_early detection and diagnosis of disease (D);
_control of contributing (predisposing, precipitating and/or perpetuating) factors (C);
_curative and least invasive management of disease or pathological effects (M); and
_assessment and monitoring of intervention outcome (O).

These tenets are not only applicable to dental caries, but also to aesthetic problems causing patients "dis-ease". Dental aesthetic problems, like other diseases, can be caused by genetic or developmental anomalies, infection agents (e.g. caries and periodontal disease) and/or environmental factors (malnutrition, diet, stress, trauma, etc.) and include:

_discoloured teeth;
_poorly shaped teeth;
_broken or worn teeth;
_ugly fillings (secondary to dental caries);
_spaces between teeth;
_crooked teeth; and
_missing teeth.

Non-invasive options	Minimally invasive options
Smile training	Aesthetic recontouring of teeth/gums
Remineralisation of white spot lesions	Direct restoration with micro-preparation, air abrasion and laser
Take-home and in-office bleaching	Direct or indirect veneers
Direct veneers without tooth preparation	Inlays, onlays and partial veneer crowns
Bonded pontics	Adhesive bridges
Bruxism guards	Dentures
Sectional orthodontics	Mini-implants
	Orthodontics

Table I

Table I_MiCD treatment options for managing various aesthetic problems.

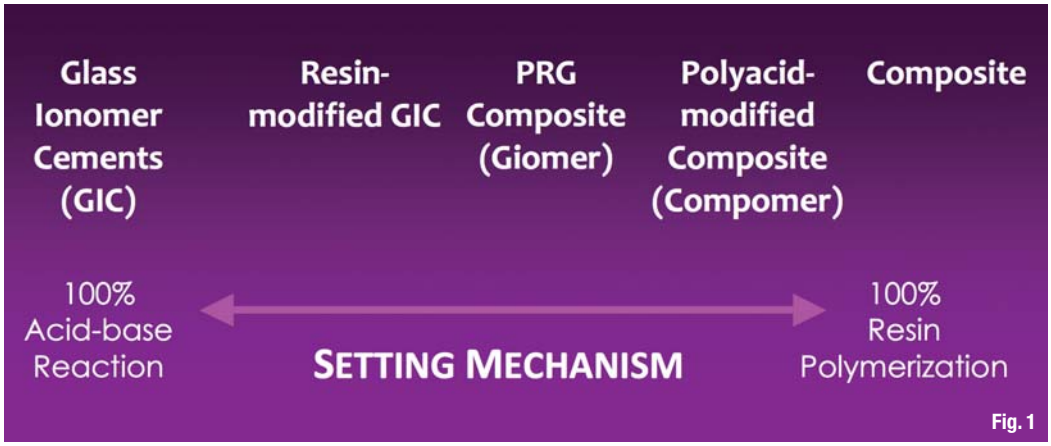

Fig. 1_Continuum of direct restorative materials used in MiCD.

Minimally invasive cosmetic dentistry (MiCD) aims to correct the afore-mentioned aesthetic disease and to fulfil patients' aesthetic desires and demands by using conservative and minimally invasive treatment options. The least amount of dentistry is performed and any tooth structure removal is kept to the absolute minimum required to achieve the desired aesthetics. The benefits of MiCD are highlighted by Koirala[2] and include reduction of dental fear, increased patient confidence, promotion of trust, enhancement of professional image, tooth preservation and reduction of treatment cost.

Treatment options can be broadly classified as non-invasive or minimally invasive and are listed in Table I. To achieve optimal aesthetic results, more invasive procedures, including conventional implants, periodontal surgery and crown therapy, are sometimes required to complement MiCD treatment options.

_MiCD materials

In view of the varied procedures, the entire range of materials used in MiCD is beyond the scope of this article. Emphasis is placed on direct aesthetic restorative materials that conserve the maximum amount of tooth structure because they are utilised in the majority of MiCD procedures performed in clinical practice. The continuum of direct restorative materials used in MiCD, based on their setting chemistry, is shown in Figure 1.

Glass ionomer cements (GICs) consist of basic glasses (calcium or strontium fluoro-aluminosilicate) and acidic co-polymers (polyalkenoic acids) that set through an acid–base reaction. The set cement consists of the original glass particles sheathed by siliceous hydrogel and bonded by a poly-salt matrix. Although their aesthetics is fair, they release fluoride and can chemically bond to tooth tissue. GICs also shrink minimally on setting and have a similar coefficient of thermal expansion to dentine.

Indications for the highly viscous version of these cements include the restoration of non-stress-bearing areas of anterior and posterior teeth and "open-sandwich" restorations. The latter involve the use of glass ionomer as a base under composite restorations. Resin-modified GICs were developed to overcome the early moisture sensitivity of conventional cements. In addition to decreasing moisture sensitivity, resin modification also improves setting characteristics, aesthetics, physical and handling properties. The resin is typically incorporated by substituting acidic co-polymers with a water–HEMA (hydroxyethyl methacrylate) mixture or the use of acidic co-polymers with methacrylate side chains. Despite the addition of resin, which usually constitutes 4.5 to 6 % of the set material, resin-modified GICs retain a significant acid–base reaction as part of their overall curing process, bond chemically to teeth and are capable of fluoride release and re-charge. Their caries preventive effect[3] and clinical uses are similar to those of their conventional counterparts.

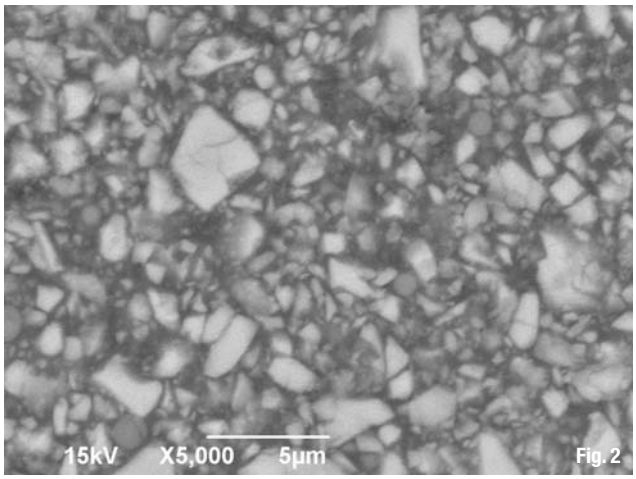

Fig. 2_SEM image of a giomer restorative with the PRG filler particles. (Image courtesy of SHOFU)

Composites, compomers (polyacid-modified composite) and giomers (pre-reacted glass ionomer composite) all require resin polymerisation to set

and intermediary bonding agents (micromechanical bonding) to adhere to teeth. They can be employed to restore all cavity classes (Class I to VI) and are especially useful for direct veneers and bonding.

Composite resins consist of a resin matrix (commonly bisphenol A-glycidyl methacrylate [Bis-GMA] or urethane dimethacrylate [UDMA] with triethylene glycol dimethacrylate [TEGDMA] as a diluent monomer), ceramic fillers (amorphous silica and silicate particles) with coupling agent and minor additives such as initiators, activators, colouring pigments and stabilisers. Resin polymerisation can be activated chemically and/or by light. Composite resins have excellent aesthetics, physical properties and handling but are technique sensitive and shrink on curing (ranges from 1 to 5 % by volume). Compomers contain the essential components of GICs. The acid component is, however, dehydrated and incorporated in the resin matrix. After light curing, the acid–base reaction occurs slowly when the dehydrated acid is activated through water sorption resulting in a partially ionic structure within the resin matrix. Compomers are capable of fluoride release but the total fluoride release and re-charge is significantly lower than that of GICs.[4] The water sorption needed for the acid–base reaction to take place has been shown to compromise the aesthetics and physical properties of compomers.[5]

Fig. 3_Panoramic radiograph of the patient.

Giomers are the most recent category of hybrid restorative material. They are touted as a true hybridisation of composites and GICs because they have the fluoride release and re-charge of GICs and the aesthetics, handling and physical properties of composite resins. Giomers are based on PRG technology in which pre-reacted GICs are used as fillers (Fig. 2). Currently available commercial products are based on S-PRG in which only the surface of the glass fillers are reacted with polyacid and a glass core remains. Examples of giomer restorative products include Beautifil II and Beautifil Flow Plus (SHOFU).

The fluoride release and re-charge of giomers are significantly better than that of compomers but lower than GICs.[4,6] A recent study has reported reduced dental plaque formation and bacterial adherence on giomers when compared with composite resins.[7] This had been attributed to the formation of a material film layer on the surface of giomer restorations after contact with saliva. This material film layer, which consists of aluminium, silica, strontium and other ions, originates from the PRG filler and has also been observed with GICs.[8]

The clinical performance of giomer restorations has been evaluated in several studies involving Class I, II and V cavities up to eight years of duration. After three years, Matis *et al.*[9] found no significant difference between giomer and micro-filled composite restorations in all the parameters evaluated. Gordan *et al.*[10] evaluated the performance of giomer restorations over eight years and report no restoration failure. Significant changes were detected only for marginal adaptation at occlusal surfaces and marginal staining at proximal surfaces. Although recurrent or secondary caries is a major cause of restoration failure,[11] this was not observed with giomer restorations. The latter may be accounted for by their better demineralisation inhibition effect at the margins of restorations when compared with compomers and composites.[12]

_MiCD in clinical practice

The spectrum of MiCD procedures and techniques involving the use of direct restorative materials has been extensively covered.[13] The modification of tooth colour, shape, size, position and defects, as well as the replacement of missing teeth, can be conservatively achieved with no to minimal tooth preparation. Psychological (perception, personality, desire), health (general, specific, dentogingival), functional (occlusion, phonetics, comfort) and aesthetic (macro, mini, micro) factors must be considered when designing a smile and this has been incorporated by Koirala into a Smile Design Wheel.[2]

The following case presentation highlights the key principles of MiD (DCMO) as it applies to aesthetic dis-ease and precautions related to MiCD.

_Case study

A 43-year-old female patient was referred by her general dentist for management of her aesthetic

Clinical signs	Radiographic signs	Symptoms
Increasing tooth mobility	Angular bony defects	Sensitive, painful or sore teeth
Fremitus and migration of teeth	Increased width of periodontal ligament space	Uncomfortable, uneven or "lost" bite
Cracked or fractured teeth/restorations	Increased width of lamina dura	Occlusion-related periodontal pain
Abfraction cavities	Changes in alveolar bone	Symptoms of temporomandibular disorders
Occlusal wear and heavy occlusal contacts	Vertical reduction of interdental septum	
Occlusal discrepancies	Root resorption	
Soft tissue indentations	Furcation defect	
Signs of temporomandibular disorders		

Table II

Table II_Signs and symptoms of occlusal disease.

problems for social reasons. She had congenitally missing lateral incisors, a history of multiple tooth fracture and was unhappy with the spaces and shape of her upper anterior teeth. With the exception of her upper right second molar, all upper molars and second premolars were lost owing to fracture. Her posterior support was derived solely from her first premolars because she had a missing lower right second molar (Fig. 3) and did not have an upper denture. Although her upper right first premolar was crowned and her left first premolar was "pristine", both teeth were cracked.

Early detection and diagnosis of disease

The patient's aesthetic problems were exacerbated by developmental anomalies (congenitally missing laterals) and environmental factors, including occlusal disease (OD). Occlusal disease is defined as "the process resulting in the noticeable loss or destruction of the occluding surfaces of the teeth".[14] The disease process is caused primarily by parafunction, especially sleep bruxism. The detrimental effects of OD could have been greatly minimised by early detection and management with a bruxism splint. Occlusal considerations are particularly important in MiCD because they have a significant impact on restoration success. The clinical and radiographic signs and symptoms of OD are listed in Table II.

As part of the diagnosis process, quality of life issues must be explored in addition to the usual history taking, examination and special tests (e.g. electric pulp test, salivary function test). Discussion of quality of life issues should focus on patients' wants, needs and expectations with regard to:

_appearance;
_tooth sensitivity;
_tooth or restoration fracture or failure;
_soft tissue discomfort;
_loosening or moving teeth;
_bite problems; and
_jaw pain and dysfunction.

If MiCD is planned in the presence of OD, patients must be educated on the advantages and disadvantages of MiCD to conventional therapy, the possibility of failure and need for protection. The patient concerned was aware of her occlusal problems but wanted a quick, non-invasive and economical solution to improving her anterior aesthetics in view of a social commitment.

Fig. 4a_Pre-treatment.
Fig. 4b_Post-treatment.


Fig. 4a

Fig. 4b

Control of contributing factors

As part of the patient's MiCD treatment planning, all factors contributing to the aesthetic dis-ease must be addressed. Contributing factors can be divided into those that increase risk (predisposing), cause the onset (precipitating) or enhance the progression (perpetuating) of the problem. Sleep bruxism, malocclusion and the loss of posterior tooth support (leading to occlusal trauma to the remaining teeth or restorations) were significant issues for the patient concerned. The contributing factors and their treatment implications were discussed in depth. The need for posterior support and future protection with a stabilisation splint was highlighted and the provisional treatment plan was formulated.

Fig. 5_Fractured direct veneers on the upper canines.

Curative and least invasive management of disease or pathological effects

Treatment according to the MiCD approach was undertaken in consultation with the patient in view of time and cost constraints. Bonding was done to close the spaces between her upper central incisors and canines and direct veneers were used to modify the shape of her canines into lateral incisors (Figs. 4a & b). The restorations were achieved using giomer restoratives (Beautifil II and Beautifil Flow) and the flowable frame technique.[13]

Some minor aesthetic recontouring was also done to the right central incisor. Impressions were made after restoration placement in preparation of an immediate denture replacing all the patient's missing posterior teeth and the fractured upper first premolars. The patient was also informed of the possibility of implants (with sinus lift and bone augmentation), should a fixed option be desired later. The need for conventional crown therapy should the bonded restorations not be durable was also discussed.

Assessment and monitoring of intervention outcome

A follow-up appointment for the seating of the immediate denture was scheduled but the patient did not attend her appointment. She was very happy with the aesthetic outcome and only returned when her bonded restorations failed a few months later (Fig. 5). The lack of posterior tooth support and high occlusal stresses secondary to sleep bruxism resulted in the failure of the bonded restorations. The latter could have been avoided if an upper stabilisation splint had been worn during sleep. Assessment and monitoring of intervention outcome is extremely important when OD is present. If teeth fracture and wear down, restorations will perform no better unless all contributing factors are addressed.

_Conclusion

MiCD aims to correct aesthetic dis-ease and fulfil patients' aesthetic desires and demands through conservative and minimally invasive treatment. Generic minimum intervention principles were proposed for all oral diseases including aesthetic dis-ease caused by genetic or developmental anomalies, infection agents and/or environmental factors. These were:

_early detection and diagnosis of disease;
_control of contributing factors;
_curative and least invasive management of disease or pathological effects; and
_assessment and monitoring of intervention outcome.

The tenets were employed in a case study in which giomer restoratives were used. The latter are the most recent category of glass ionomer–composite hybrid restorative materials. They are particularly useful for MiCD procedures in view of their good aesthetics, handling and anti-caries properties._

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