

## **Biomimetic Dentistry: Less Drilling More Healing**

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### **DECLARATION OF INTERESTS**

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### **Abstract**

Biomimetic dentistry is an alternative approach in dentistry for dental caries management. It takes the potential advantageous features of maintaining, mimicking and replacing of natural dental tissues (enamel & dentin) in the mouth without using toxic restorative materials. Ultraconservative treatment is recommended for treating cavitated dentin lesions. Thus, Atraumatic Restorative Treatment is the most commonly used technique these days by dental clinicians worldwide. It is intended to both prevent dental caries and also to stop its further progression in the long-term. This short overview will attempt to provide a better understanding of biomimetic dentistry in terms of preventive/conservative approach for carious lesion removal and also to give a clinical perspective for Libyan dental clinicians.

### **Keywords**

Biomimetic Dentistry, Dental Caries, Atraumatic Restorative Treatment (ART), Enamel, Dentin

### **Background**

The term “biomimetic” means bio (life-like) and mimetic (copy) (1). The main principle of biomimetic dentistry is to restore damaged tooth tissues with restorations that mimic the natural teeth in appearance, function and strength (1-3). It has been developing in order to improve

requirements of restorative filling materials and procedures of carious lesion removal, which leading to minimising tooth preparation and maximising pulp vitality. Once the tooth damaged, the body is unable to repair or regenerate the lost or missing

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dental tissues; thus the biomimetic principles should be used to artificially repair the damaged tooth tissues in order to return its nature function, strength and aesthetic parameters (4,5).

Dental caries is the most prevalent oral disease in the world. It is un-balanced mechanism of re- and de-mineralisation, causing loss of minerals like calcium ( $\text{Ca}^{2+}$ ) and phosphate ( $\text{PO}_4^{3-}$ ) ions of natural dental tissues (6). It is believed that these species ( $\text{Ca}^{2+}$  &  $\text{PO}_4^{3-}$ ) would be available in aqueous media in ratio close to the apatite stoichiometry ( $\text{Ca/P} = 1.67$ ) as eventually deposit a tooth mineral, thereby enabling formation new apatite crystals on tooth surfaces; according to the apatite equilibrium equation in Figure 1. Many studies have been suggesting that the new developed restorative materials have great potential to promote re-mineralisation at expense of inhibition de-mineralisation process (7-9).

Several clinical approaches to treat dental caries lesions focus on conserving treatment of the tooth surfaces. Considering this, Minimally Intervention Dentistry (MID) is a crucial concept which

### **Biomimetic Approach for Restorative Dentistry**

It is well known that, traditional dental procedures for carious lesion removal depend on preparation designs

includes three aspects to fulfil the requirement of preventive/conservative dentistry; these are early caries diagnosis, enhance re-mineralisation and minimal cutting of tooth surfaces (10,11). This approach is identified as an Atraumatic Restorative Treatment (ART). This technique was adopted in 1994 by the World Health Organisation (WHO) as an alternative technique for dental caries management in the developed countries either for treating deciduous or permanent dentitions (10,12). The ART technique is achieved by excavation soft, de-mineralised tooth tissue with hand instruments instead of using drilling instruments, followed by restoring the cavity with a high viscous GIC using “press finger technique” (13,14). Therefore, the scope of preventive/conservative approach (biomimetic dentistry) is to replace the lost, damaged dental tissues in a similar manner that matches the natural processing mechanism of mineralisation (as seen in figure 1) and this will open a new era for dental caries management in dentistry.

(preparation a cavity) that accommodate the restorative materials. This includes preparation features such

as retention and resistance form, as well as tooth reduction to meet the strength requirements of the restorations instead of prioritising the preservation of intact tooth structures (5,15). As a result, the restored tooth has a significant additional preparation in association with a higher chance of various complications; such as pain, post-operative sensitivity, root canal treatment and fracture. While, biomimetic restorations only need replacing the damaged portions which conserves the maximum amount of the intact tooth structures with less drilling and less endodontic treatments, in other words with less complications.

Further, it is not able to distinguish between infected and affected dentin during conventional drilling, and also the

susceptibility of pulp espouse is quite high; the differences between infected/affected dentin are shown in Table 1. Consequently, in order to minimise the risk of pulp exposure during removal of carious lesion, conservative techniques (ART protocol) have been followed; including complete (removal of all infected dentin), partial removal and stepwise excavation (16). The clinical evidence indicates that both partial removal of damaged tooth tissues and stepwise excavation have exhibited lower pulp exposure rates and higher success rates than complete excavation (16,17). Thus, ART technique should be an important component of the comprehensive preventive/conservative program for Libyan dental clinicians to meet the needs of their patients

### **Biomimetic Approach for Re-mineralisation**

The concept of re-mineralisation mechanism of restorative materials is still controversial and very few studies have been done on evaluation this process in vivo or in vitro. It is well known that the re-mineralisation is a process of restoring and replacing the missing minerals

(Hydroxyapatite = HA;  $\text{Ca}_5(\text{PO}_4)_3\text{OH}$ , Fluorapatite = FA;  $\text{Ca}_5(\text{PO}_4)_3\text{F}$  or Strontium Fluorapatite = SrFA;  $\text{Ca/Sr}_5(\text{PO}_4)_3\text{F}$ ) of tooth surfaces in order to achieve balancing mechanism (18,19).

The majority of exciting restorative filling materials are not bioactive and

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not biocompatible. Both amalgam and composite release toxic products which has harm effect on patients and dentists. Number of drawbacks is associated with using the these materials; including mercury release, lack of aesthetics for amalgam, as well as poor bonding ability to tooth surfaces and polymerisation shrinkage for composite; which cause microleakage at the interfaces between restoration/tooth, this commonly leads to a recurrent caries occurrence (20).

On the other hand, the ideal restorative filling material (biomimetic material) would be the one that can easily degrade in the mouth and then being replaced by natural tooth enamel and/or dentin (21,22). Currently, ion-leaching silicon-containing materials (smart materials) are made headway towards this

goal and also to be capable to form apatite crystals in the mouth (21-23). The fact that, availability of calcium ( $\text{Ca}^{2+}$ ), phosphate ( $\text{PO}_4^{3-}$ ) and fluoride ( $\text{F}^-$ ) ions at the interfaces between the restoration/tooth surfaces and/or the restoration/oral environment would eventually help deposition new tooth minerals, thereby enabling re-mineralisation of damaged tooth tissues.

No doubt, it is still needed to improve the bioactivity of ion-leaching silicon-containing restorations to develop the re-mineralising ability of these materials with the purpose of apatite formation to mimic the tooth mineral itself. The question remains how long these smart materials will take to yield apatite crystals at the interfaces in the long-term.

## Conclusion

Biomimetic approach (particularly ATR technique) has to be approved by Libyan dental clinicians in order to achieve re-mineralisation of the lost, damaged dental

tissues and essentially to change protocol of restorative treatment from drill and fill to seal and heal.

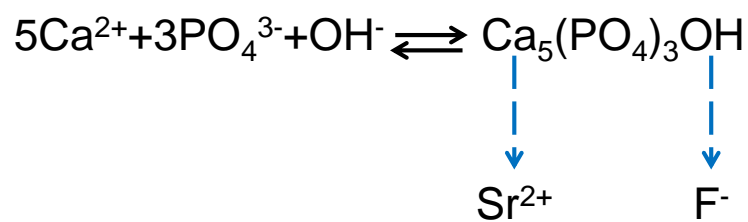
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**Figure and Table Legends**



**Figure 1:** Equation of apatite equilibrium. Hydroxyapatite  $[\text{Ca}_5(\text{PO}_4)_3\text{OH}]$  crystal; is produced by combination of calcium ( $\text{Ca}^{2+}$ ), phosphate ( $\text{PO}_4^{3-}$ ) and hydroxyl ( $\text{OH}^-$ ) ions together, fluorapatite

$[\text{Ca}_5(\text{PO}_4)_3\text{F}]$  crystal; is formed by fluoride ( $\text{F}^-$ ) ion substitution for hydroxyl ( $\text{OH}^-$ ) ion and strontium fluorapatite  $[\text{Ca}/\text{Sr}_5(\text{PO}_4)_3\text{F}]$  crystal; is created by strontium ( $\text{Sr}^{2+}$ ) ion substitution for calcium ( $\text{Ca}^{2+}$ ) ion.

**Table 1:** The differences between infected and affected dentin

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<b>Criteria</b>	<b>Infected Dentin</b>	<b>Affected Dentin</b>
<b>Location</b>	Outer layer	Inner layer
<b>Consistency</b>	Soft	Hard
<b>Microorganisms Content</b>	It contains	Doesn't contain
<b>Ability to Re-mineralise</b>	Un-able	Able
<b>Vitality</b>	Un-vital	Vital