Biomimetic Materials: A Miraging Camouflage

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ABSTRACT
The adoption of biomimetic strategies exemplifies the "less is more" approach, ensuring maximal preservation of tooth structure while mitigating future risks via ultraconservative approaches, minimally invasive procedures and the integration of function, strength, aesthetics, and longevity in dental treatment. By shifting from the traditional paradigm of "extension for prevention" to "preservation for prevention," biomimetic dentistry offers a transformative approach that aligns with the principles of minimally invasive dentistry and patient-centered care.

Keywords: ultraconservative, minimally invasive, ozone therapy, regeneration, multifaceted

Introduction

Biomimetic dentistry comes from the concept of-‘mimicking’ an art known to organisms from centuries, integrating it with the use of biological principles and integrating it into dental setups forms the core of biomimetic dentistry.

Objectives

To delineate the multifaceted use of biomaterials and their importance in various disciplines of dentistry. An insight to the economical angle of biomimetic dentistry as opposed to the loop of traditional dentistry.

Biomaterials

Glass Ionomer Cement

Use of GIC as a tooth coloured restorative material is well known to dentists. Highly advantageous properties like minimum polymerisation shrinkage, a chemical bond with tooth structure, favourable pulpal response, fluoride releasing anticariogenic property, minimal microleakage, lesser cavity preparation requirements, GIC qualifies as a perfect candidate material for practicing biomimetic dentistry.

Ceramics

Wide range of dental applications of ceramics- inlays and onlays,esthetic laminates,veneers,all ceramic crowns, short span bridges, ceramic orthodontic brackets,artificial dental teeth are successful due to high modulus,compressive strength,low coefficient of friction,high corrosion resistance. Alumina coated with calcium infused hydroxyapatite crystals put an in the game effect for highly biocompatible osseointegrated implants in oral environment.

Synthetic Polymers

An age old adage still stays true regarding the use of cross linking to establish a union of benefits of practicing traditional dentistry and biomimetics. Reduced requirements of cavity preparation account for its inclusion as a biomaterial.

Calcium Hydroxide

For procedures -indirect and direct pulp capping. It serves to stimulate the formation of reparative dentin while facilitating remineralization, thereby preserving the vitality and function of the dental pulp and reducing the need for cumbersome, time consuming procedures and saving the tooth in long run by allowing it the time and space to heal on its on by using its some of natural tendencies.

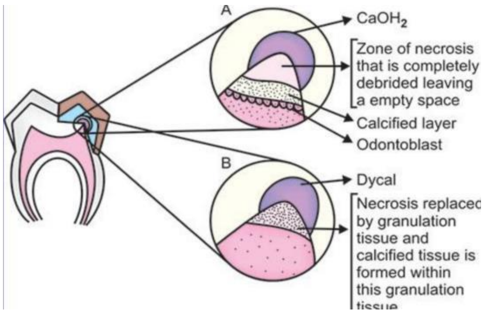

Figure 1-Use of Calcium Hydroxide for pulp capping

Mineral Trioxide Aggregate (MTA)

Applications, Apexification, apexogenesis, perforation repair, and root-end filling during endodontic treatments is made possible by its exceptional biocompatibility, sealing properties, and capacity to induce tissue repair.

Biodentin

Bioactive dentin substitute utilized for pulp capping, pulpotomy, and direct pulp capping procedures. It prompts reparative dentin formation, facilitates pulp tissue repair, and aids preserving dental pulp vitality.

Fluorides

A pivotal role for caries prevention and remineralization of early enamel lesions. Through treatments such as topical fluoride varnishes and fluoride-containing toothpaste, fluorides increase enamel resistance to demineralisation by acids, foster the formation of acid-resistant fluorapatite,increase the rate of post eruptive maturation,remineralisation of the incipient lesions, alter the plaque microflora, induce changes in the tooth structure.

Enamel Matrix Derivatives (EMD)

EMDs for periodontal regeneration and treatment of intrabony defects. These derivatives, containing proteins akin to natural enamel matrix, foster regeneration of periodontal tissues including cementum, periodontal ligament, and alveolar bone.

Bone Morphogenetic Proteins (BMPs)

Growth factors to stimulate bone formation and regeneration in procedures like ridge augmentation and

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sinus lifts by promoting osteogenesis and angiogenesis, augmenting the natural healing process and enhancing bone quality and quantity.

BMP-1	Not part of TGF-β family
BMP-2	Osteoinductive, osteoblast differentiation, apoptosis
BMP-3 (osteogenin)	Most abundant BMP in bone, inhibits osteogenesis
BMP-4	Osteoinductive, lung and eye development
BMP-5	Chondrogenesis
BMP-6	Osteoblast differentiation, chondrogenesis
BMP-7 (osteogenic protein-1)	Osteoinductive, development of kidney and eye
BMP-8 (osteogenic protein-1)	Osteoinductive
BMP-9	Nervous system, hepatic reticuloendothelial system
BMP-10	Cardiac development
BMP-11 (growth/differentiation factor-8)	Neuronal tissues
BMP-12 (growth/differentiation factor-7)	Tendon-iliac tissue formation
BMP-13 (growth/differentiation factor-6)	Tendon and ligament-like tissue formation
BMP-14 (growth/differentiation factor-5)	Enhances tendon healing and bone formation
BMP-15	Follicle-stimulating hormone activity

BMP: Bone morphogenetic protein, TGF: Transforming growth factor

Figure 2-Various Bone Morphogenic Proteins and their functions

Regenerative Endodontic Materials

Blood clot, platelet-rich plasma (PRP), and scaffold materials for regenerating pulp tissue and dentin in necrotic immature permanent teeth. These materials create a conducive biological environment for stem cell recruitment, differentiation, and tissue regeneration within the root canal space.

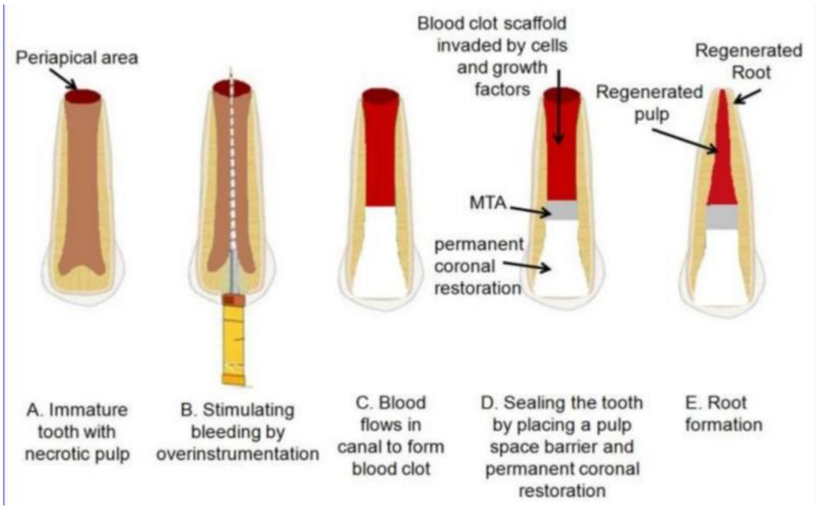

Figure-3 Regenerative Endodontics

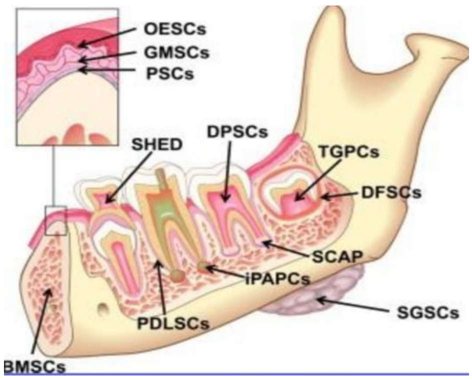

Figure-4 Various stem cells Employed in Regenerative dentistry

Multipotent stem cells for Temporomandibular Joint reconstruction

Differentiation of Multipotent stem cells into osteogenic and chondrogenic cells, encapsulated polyethylene glycoldiacrylatehydrogel. Later on these are molded into stratified and integrated layers of cartilage and bone, which forms an adult mandibular condyle. An attempt for craniofacial reconstruction through biomimetics.

Median Condyle Cartilagenous and Bone

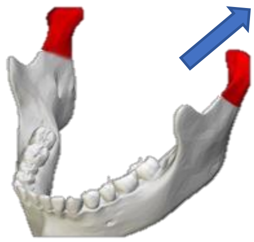

Figure 5- Temporomandibular Joint Reconstruction

Bioactive Glass

Teeth subject to cyclic exposure to low-pH demineralizing solutions followed by amplification and subsequent remineralization with physiologic pH solutions, revealed a reduced reduction in enamel microhardness, particularly notable at depths of 25 and 50 µm, observed across all distances from the bracket edge when utilizing BAG-Bonds compared to the traditional bonding agent. Furthermore, a significant decrease in superficial enamel softening surrounding orthodontic brackets compared to the conventional bonding agent. This observed reduction in enamel softening has the potential to mitigate the occurrence of white spot lesions commonly associated with orthodontic treatment.

Figure 6- White spot lesions seen around orthodontic brackets post-operatively

TheraCal

A light-cured silicate resin serves as a layer underneath restorative materials ,in comparison to Dycal and MTA, shows lower solubility of calcium ion complexes and higher release.

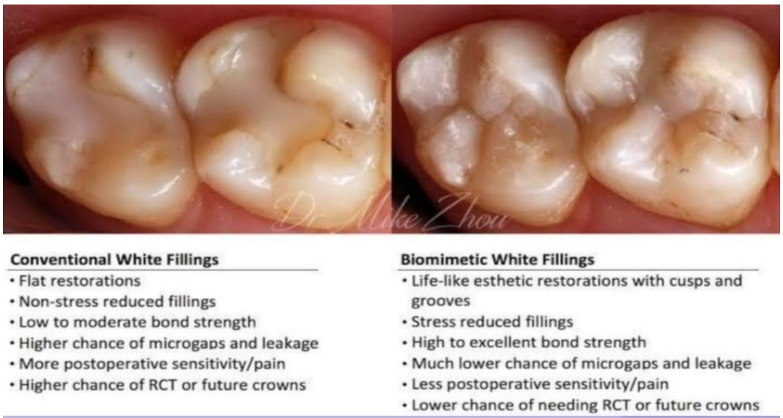

Figure 7 - Comparison between traditional and biomimetic dentistry

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