REVIEW ARTICLE

ERA OF BIOMIMETIC RESTORATIVE DENTISTRY- A NARRATIVE REVIEW

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ABSTRACT

Advancement in restorative material science and better understanding of bonding have influenced the treatment approach for restoring dentition. Thus evolved the concept of biomimetics in the field of restorative dentistry. Biomimetic dentistry helps to recreate the form, function and aesthetics of the dentition in a natural way. This narrative review intends to give an overview of biomimetics in restorative dentistry.

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INTRODUCTION

The word 'biomimetic' is derived from a Latin word, where "bio" means life, and "mimetic" means imitation or mimicking.[1] Hence biomimetic is the art of mimicking nature. The term was put forward by biomedical engineer Otto Schmitt in the 1950s.[1] It is a multi-disciplinary approach, where inspiration elicited from nature is used to design products that mimic nature, so that it functions biologically. In the past two decades the principles of biomimetics have been incorporated and extensively explored across various fields of dentistry including remineralisation, restoration, endodontics, regeneration etc.

Biomimetics in restorative dentistry

For a restorative dentist an indubitable reference is the natural tooth itself. Biomimetics in restorative dentistry involve restoring the functional, mechanical and aesthetic requirement of teeth as naturally as possible[2]. Basically it aims to replace the damaged portion of teeth far more conservatively in contrast to the traditional tooth preparation which involves extensive and invasive preparations to facilitate retention and resistance forms. In brief the traditional restorative techniques was to prioritise the need of the material rather than tooth needs.[3] Biomimetics in restorative dentistry was facilitated and supported by the developments and evolution in dental composite resins, clinical adhesives and dental ceramics.[4,5]

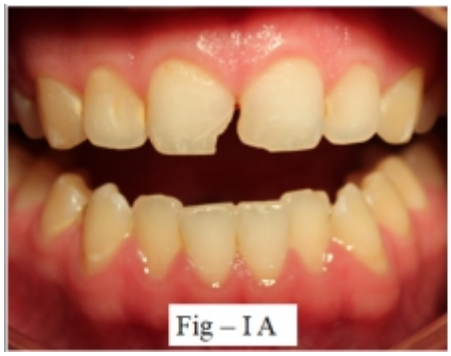
Material of Choice for Biomimetic Restoration

Biomimetic restorative material should not only satisfy the aesthetic and mechanical requirement but also it should be bio-compatible. A thorough understanding of hard tissue arrangement of tooth is crucial for successful selection and usage of a material for biomimetic restoration.[2] Enamel and dentine act as a complex structure complimenting each other. In natural tooth the hard brittle and glass like enamel is supported by soft resilient dentin. The resilient dentin provides a cushioning effect by virtue of the collagen, which clinically arrests crack propagation from the enamel. In brief it compensates for the brittleness of enamel.[6] A biomimetic restoration should mimic these features. Further to it there should not be any discrepancy in the mechanical properties such as elastic modulus and surface hardness of teeth and restorative material. Such discrepancy if notable or remarkable can lead to fracture of tooth, marginal leakage, and plaque accumulation, which in turn would affect the clinical performance of the restoration in the long term.[7,8] In order to achieve biomimetics the enamel should be replaced with brittle, hard, glasslike, translucent material, whereas dentine which needs replacement should be substituted by resilient material.

From the clinical perspective let us take the example of few newer material used in contemporary dentistry. Newer dental ceramic made of lithium dislicate popularly called as LiDiSi has an elastic modulus (EM) ranging 60 - 95 GPa. This elastic modulus is comparable to that of natural enamel (EM 72-125). Added to this is the high aesthetic resemblance to the enamel of the tooth, whereas on the other hand dental resin composites have a EM of 13-18 GPa which is comparable to that of the natural dentine (EM-14 - 38Gpa) so can be a better alternative to replace dentin. This implies that in case of minimal to moderate tooth loss dental composites alone can behave as a good biomimetic restorative material (fig-I-A & I-B), which can re-enforce the remaining tooth structure[9]. And in case of larger defects usage of the newer LiDiSi having properties similar to enamel is deemed better(fig II-A,II-B,III-A& III-B)[10].

Adhesion - Corner Stone of Biomechanical Restoration

Dental adhesives commonly termed as bonding agents play a crucial role in achieving predictable outcome in biomimetic restoration. Perfect bonding between the restorative



Small defect on incisors (Fig-I A) corrected using Composite Resins (Fig-I B)
(Photo Courtesy – Dr Prasanth Dhanapal)

Large defect on molar (Fig-II A) corrected using LiDiSi inlay (Fig-II B)
(Photo Courtesy – Dr Prasanth Dhanapal)

Large defect on premolar (Fig III-A) corrected using LiDiSi onlay (Fig III-B)
(Photo Courtesy - Dr Prasanth Dhanapal)

material and the tooth creates a monoblock. This monoblock by virtue of absence of interfaces allows the functional stress to get dissipated through tooth structure. Thus restoring mechanical and biological function of the tooth optimally.[10] Proper selection and usage of state of art adhesives seals the gap between the material and the tooth structure optimally so as to prevent sensitivity, pain, bacterial leakage and pulpal damage in the long term[11]. It also contributes considerably for the tooth to handle functional stresses similar to the natural tooth.[12]

Utilization of adhesive protocols would eliminate the need for extensive tooth destructive mechanical retentive features which would enable tooth conservation to a larger extent satisfying one of the main objectives of biomimetic restorative dentistry.

The Protocols for Biomimetic Restorative Dentistry

The basic protocols for biomimetic restorative dentistry were found on an article 'silent revolution of adhesive dentistry'.[4] Further advancements were made by Japanese researchers, where in newer technologies were introduced to get a predictable bonding to dentine .[13,14]

The four paradigms of biomimetic dentistry involves,

- Maximum bond strength, which allows the restored teeth to function and handle stress like that of natural tooth.
- Good marginal seal so as to prevent further microbial invasion.[15]
- Increased pulp vitality leading to increases in fracture resistance three times than restored teeth[16].
- The ultimate goal of biomimetic restorative dentistry is to reduce the stress and maintain maximum bond strength hand in hand.[17]

The protocols that have been advocated to follow these paradigms can be classified in to two – stress reducing protocols and bond maximising protocols.

Stress reducing protocols include the usage of indirect restorations (to reduce the development of compressive stress), replacing the lost dentine with composite of similar EM so as to help absorb and dissipate the stress evenly, use of fibers on the pulpal floor and axial wall to cause hindrance to crack propagation), capping of the cusp thinner than 2mm, converting the tensile forces in to vertical compressive forces (compression dome concept.[8,9,18,15]

Compression dome concept (fig- I): A natural tooth is designed to tolerate compressive stress than tensile stress. Tooth can be compared to a dome of cathedral where the forces acting on the top portion of the dome produces vertical stress, and forces acting away from the top of the dome generate tensile stress (fig-IV). Based on this concept when the tooth margins are placed more cervical as if in conventional

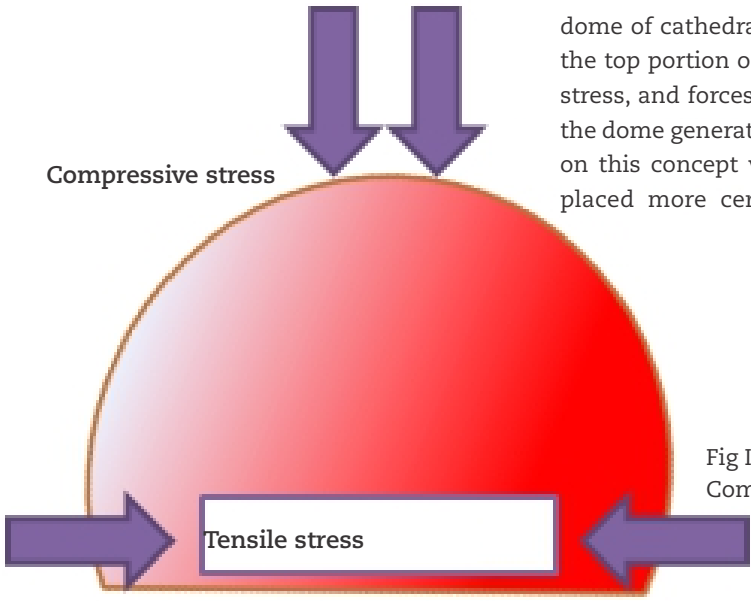


Fig IV
Compression Dome Concept

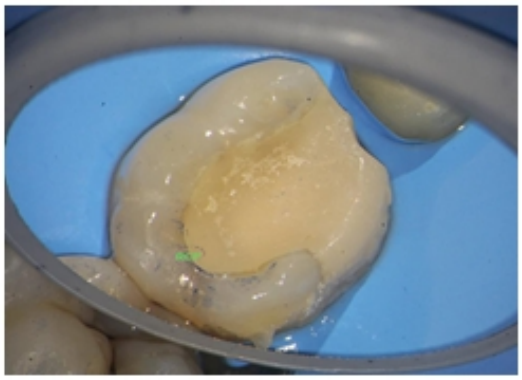


Fig-V A: Large defective restoration on mandibular molar

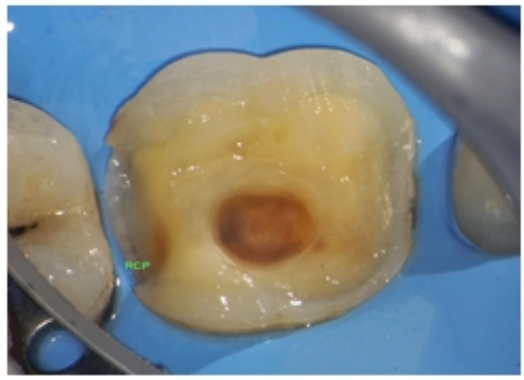


Fig-V B: Tooth preparation for table top restoration

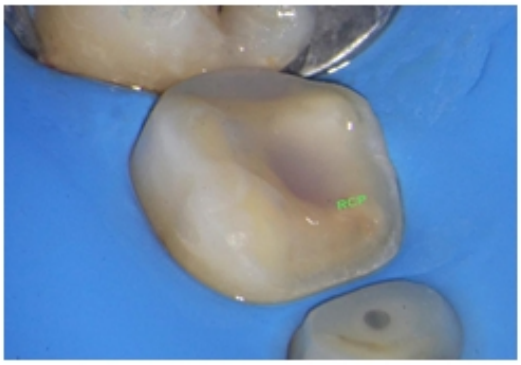


Fig-V C: Immediate dentine sealing and undercut blocking

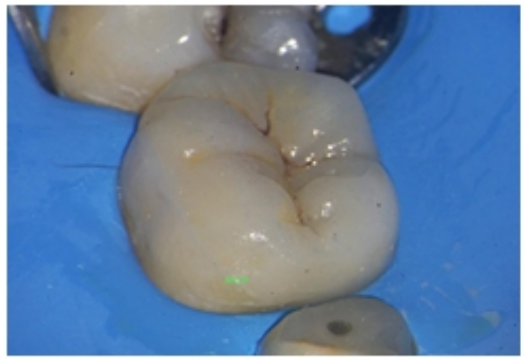


Fig-V D: Occlusal table top on mandibular molar

Fig V (B, C, D) - Placement of preparation margins more occlusaly to avoid tensile stress (Photo Courtesy - Dr Jojo Kottoor)

crown preparation lateral stresses are created which are more destructive in nature in comparison to the forces generated by margins placed far more occlusally as in case of onlays, overlays and tabletop preparations (fig-V). In a more occlusally placed margins the tensile stresses are transformed into a more vertical tangents which are better tolerated by the tooth.[19]

Bond maximisation protocols on the other side of the spectrum involves using of a good bonding agent, achieving a caries free healthy tooth as the bonding substrate, air abrading the underlying composite, de-activating of matrix metallo-proteinases, immediate dentine sealing and deep margin elevation whenever required.[20]

The combination of each protocol with due care and caution helps to attain a predictable long standing restoration.

CONCLUSION

In the past two decades numerous advancements in the field of biomimetic restorations have happened and it is still evolving positively. However, the proper understanding and utilization of available material, technology and protocols would prove to yield promising results which would definitely benefit the restorative dentist and the patient.

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