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RESEARCH ARTICLE

BIOMIMETIC MATERIALS IN PEDIATRIC DENTISTRY: FROM PAST TO FUTURE

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Abstract

With the arrival of technology, during the last two decades, various changes have been made in the field of restorative dentistry. Hence, this article reviews the numerous biomimetic materials and its biological properties in the field of restorative and preventive dentistry and endodontics. Biomimetic materials, with their biocompatible nature and physio-chemical properties are widely used nowadays.[1] They can function as long-lasting aesthetic and restorative materials, cements, root repair materials, root canal sealers and filling materials, which have the advantages of enhanced biocompatibility, high strength, sealing ability and antibacterial properties. Newer biomimetic materials have the ability to overcome limitations of earlier generation materials.[1]

Introduction:-

"Why biomimetic material should be used in pediatric dentistry?"

Because of **high flow rate of saliva and uncontrollable movement of tongue**, it become very difficult for Pediatric dentist to provide better sealing of restorative material in cavity.

Where these material can act as "game changer "by their excellent ability of sealing to stop from leakage other additional benefits for example protect against breakdown at the margins of a restoration because materials used in biomimetic treatment are specifically designed to imitate the elasticity and durability of natural dentine and enamel.[2]

Biomimetics which is also known by other terms example **'biomimesis', 'biomimicry', 'bionics', 'biognosis',**These are biologically inspired design which copying or adaptation of similar biological matrix.In Dentistry where restoring the natural tooth with maximum natural physio mechanicalfunctioning are primary goal for both patient and dentist.Biomimetic material work as boon and remarkable result with patient satisfaction and improvement in prognosis of treatment.They can function as long lasting aesthetic and restorative materials, cements, root repair materials, root canal sealers and filling materials, which have the advantages of enhanced biocompatibility, high strength, sealing ability and antibacterial properties.[2]

As we know that **GIC**itself is a biomimetic material invented in 1969because of its properties of releasing fluoride,which is bactericidal in nature and also helps in stimulating sclerotic dentine formation. It mimics the functional strength of dentine. It is also known as **"MAN MADE DENTINE "and "Dentine substitute".** Awell-known technique Direct sandwich technique where GIC is used as a biomimetic dentine substitute as a base prior to placement of composite.[3]

Recent advances like Compomer, self -hardening GIC, Low viscosity/flowable GIC, Bioactive glass, Fibre-reinforced GIC,Proline-containing GIC, Calcium aluminate GIC , Nanotechnology in GIC.[3]

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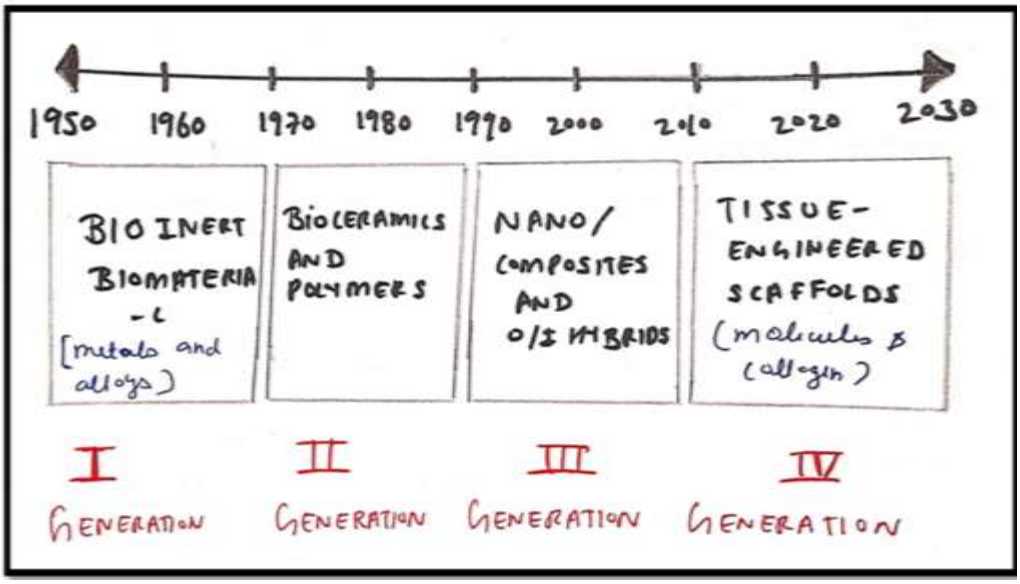
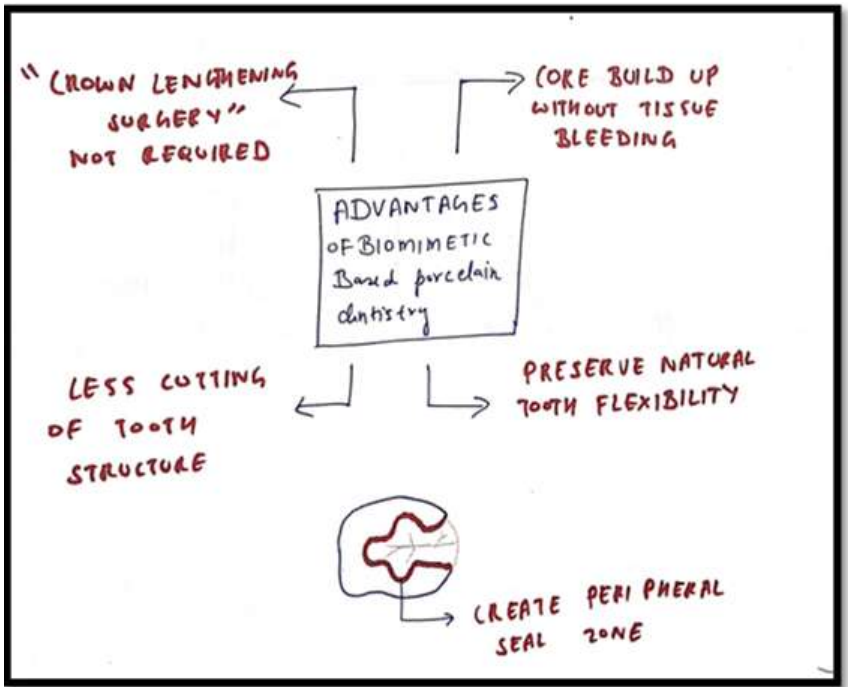
The goal of biomimetic in Pediatric Restorative Dentistry is to restore all the prepared dentine tissues to full function by the creation of a hard tissue that allows functional stress to pass through tooth advantages of composites which involves **"minimal preparation'** hence decreasing pulpal involvement and decreasing prognosis of fracture. Dental composites are composed of synthetic polymers, inorganic fillers, initiators, and activators that promote light-activated polymerization of the organic matrix to form cross linked polymer networks, and silane coupling agents which bond the reinforcing fillers to the polymer matrix**. Recent Advanceslike ORMOCER, Stimuli responsive Composite , Giomer and antimicrobial Composite helps in achieving fullest of biomechanical functions of tooth.**[3]

Bioactive Glass (2nd Gereration)



Mimic natural hard tiisue composition and have "Bio-Active role in regeneration" and have superior surface area with higher dissolution rate and thus faster apatite formation.PerioGlas® has been extensively used in periodontal surgical procedures to stimulate bone regeneration, especially in interproximal bone defects due to its haemostatic effect on trabecular bone.



Dr. Hawryluk create a more biologically acceptable restoration where gum surgeries can be avoided In addition, it creates a **"fail-safe"** design for dental work, which is easily repairable in the future. Crowns which are made unnecessarily are failed in the long term. Dr. Hawryluk Jr. strives to create**fail-safe**dental restorations. Such dental restorations have limited or no potential for recurrent cavities, protect the tooth from cracking, are easy to repair and maintain in the long run, and preserve the tooth.These are "**porcelain based restoration".**[4]

A newer CERAMIC based material name **"CERCON" (new standard Zirconia for colour standard)** recently introduced in dentistry,it give a whole new image to prosthetic care dentistry where it integrates with natural contours of mouth.[4]

AESTHETIC	• Great improved light transmission • Outstanding translucency • Natural depth effects

FAST	• Fast and safe road for desirable shade
SAFE	• Conservative preparation

MTA (Mineral Trioxide Aggregate)is a powder consisting of fine hydrophilic particles of tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide.It is a material of choice for vital pulp therapy, apexification and apexogenesis, as well as for root-end filling material in apicoectomy procedures.In primary tooth its is used for:[5]

1. Pulp capping
2. Pulpotomy
3. Root canal filling i
4. Furcation perforation repair
5. Resorption repair

Biodentineis a calcium silicate based biomaterial, which gain popularity because of its resemblance with MTA, used in clinical applications ex. root perforations, apexifications, resorptions, retrograde fillings, pulp capping procedures, and dentin replacement. Its direct contact with the connective tissue has the potential to affect the viability of peri radicular and pulpal cells. In a study by Zhou et al.,where Biodentine,MTA and GIC were compared and Biodentine were found to be less toxic than GIC.[6]

"Biomimetic Mineralization of Enamel and Dentin A Current Approach in Restorative Dentistry"

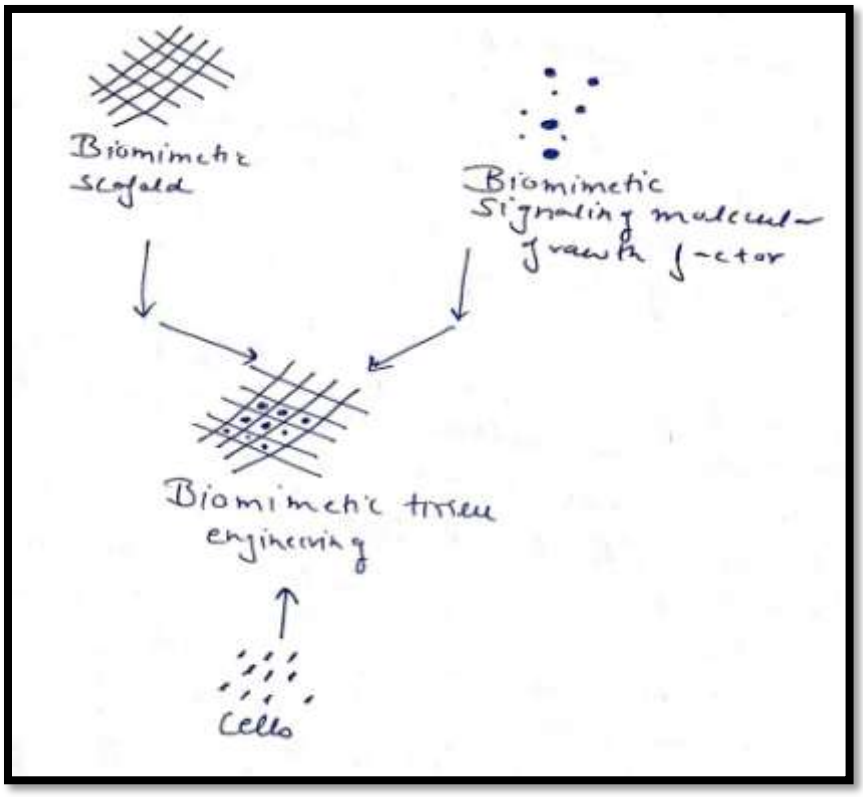
A variety of remineralizing approaches namely fluoride surfactants , electrolytic deposition , hydrothermal methods and hydrogen peroxide have been introduced to restore initial enamel caries and inhibit further enamel

demineralization. But recently a newer method where synthesis of "enamel-like apatite structures" through biomimetic approaches which Encourages outcomes with regard to enamel biomimetic mineralization by employing **proteins and protein analogues(4th generation).**In a study it is proven that application of NCP(non-collagenous proteins) analogues helps in remineralization of intrafibrillar and interfibrillar remineralization of dentine collagen fibrils.[5]

Biomimetic Tissue-Engineering Aspects

There fundamental principles applied in the field of tissue engineering are as follows:-

1. Implantation of biomimetic scaffolds that facilitates cells differentiation, proliferation and biosynthesis.
2. The cellular adhesion with the surrounding tissues, which creates new matrix formation
3. delivery of growth factors that support and indorse cells functions.



Biomimetic scaffold involves "**immune-inert biomaterials**" which regulate the immune system that applied in which decreased T and B lymphocytes and natural killer cell activity was mediated. One of the important property is the **"bioactivity"** of biomimetic scaffold. There are various techniques using which Bioactive glass scaffolds are fabricated.[6]

Materials for Biomimetic Scaffold Fabrication

the biomimetic biomaterials including polymers, bioceramics, and metals are used for several tissue-engineering applications including regeneration of dentin, pulp, alveolar bone and cartilage, and restorative treatments.

Polymers

polysaccharides (dextran, amylose, cellulose, chitin, and glycosaminoglycans), polynucleotides (RNA, DNA) and proteins (collagen, actin, fibrinogen, elastin, myosin, keratin, gelatin and silk).[7]

Bioceramics have been widely used in the regeneration of hard tissues due to their distinctive features such as biocompatibility, good bioactivity, **osteoinductivity,** and Recently,in a study it was observed that a bone defect due to ameloblastoma has been filled successfully with a nanocrystallinee, ceramic HA enriched with magnesium.[7]

Metals

Potential metals that are used in 3D printing of scaffolds are chromium, cobalt, stainless steel, titanium alloys and nitinol.[8]

Dental Stem Cells Therapy for Biomimetic Tissue Regeneration

Stem cells are undifferentiated, immature cells capable of cell differentiation and self-renewal. Stem cells therapy is an advanced procedure for the treatment of degenerated tissues that can be used by administer cells of appropriate regenerative potential. There are various types and sources of post-natal dental stem cells. To regenerate damaged oral structures, stem cell-based tissue-engineering approaches can be used. However, to ensure safe and effective use of stem cell therapy, it is mandatory to understand the basic molecular mechanisms underlying stem cell fate.[9]

Conclusion:-

Bioactive materials can be considered as boon to dentistry because of its regeneration potential. Thus in the near future it can be expected that there will be better possibilities in the field of restorative dentistry in the form of bioactive and biomimetic materials. Improvement in adhesion, integration, and sealing of dentin are possible due to bioactive and biomimetic technologies. These materials behave more like natural teeth and will definitely change the way we think about restoring teeth.[9]

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