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Biommimetic Materials in Dentistry: An Overview

Dr.Vishal Mahajan[1], Dr. Sarvesha Bhondwe[2], Dr.Rohit Dhoot[3],
Dr. Rutika Bhangde[4], Dr. Sandeep Patil[5]

Abstract: *Quest for newer material are never ending especially in the field of dental science. Various materials have been formulated, tested, and standardised to obtain maximum benefits for good clinical performance.[1] Bioactive materials have been used in every field of dentistry and medicine.[2] An ideal orthograde or retrograde filling material should seal the pathways of communication between the root canal system and its surrounding tissues. It should also be non toxic, non cariogenic, biocompatible, insoluble in tissue fluids, and dimensionally stable.[1] These materials are broadly used in the field of conservative dentistry for regeneration, repair and reconstruction. These materials are available in different form and composition that acts directly on vital tissue inducing its healing and repair.[2] A material is said to be bioactive if it gives an appropriate biological response and results in formation of bond between material and the tissue. Materials used in dentistry can be classified as bioinert(passive), bioactive, and bioresponsive or smart materials based on their interactions with the environment.*

Keywords: *Biomimetic, Bioactive, Bioinert, Bioresponsive*

I. Introduction:

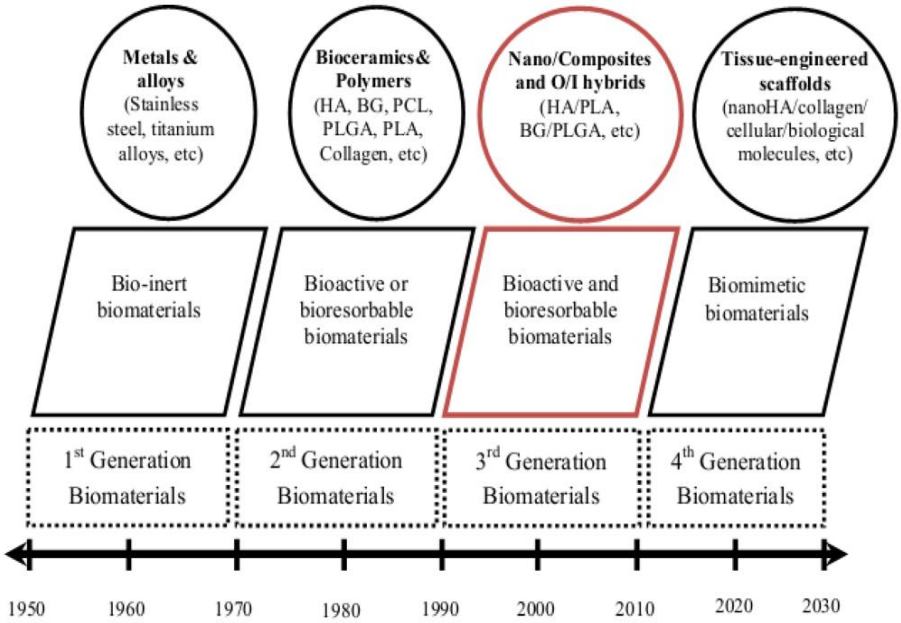
The terms bioactive, bioinductive, biomaterial and biomimetic are different and have been defined separately.[2] Bioactive material is defined as a material that has the effect on or eliciting a response from living tissue, organisms or cell such as inducing the formation of hydroxyapatite. The bioinductive property is defined as the capability of a material for inducing a response in a biological system. Biomaterial is defined as any matter, surface or construct that interacts with biological systems. Biomimetics is the study of formation, structure or function of biologically produced substances and materials (such as silk or conch shells) and biological mechanisms and processes (such as protein synthesis or mineralization) for the purpose of synthesizing similar products by artificial mechanisms that mimic natural structures. [2]

The various bioactive materials are calcium hydroxide, mineral trioxide aggregate (MTA), Biodentine, Bioactive glass, and Bioceramics .

The objectives for this review are:[3]

1. Discuss and understand the various compositional and material elements of certain biomimetic and bioactive dental materials utilized in endodontics
2. and now increasing being applied in restorative dentistry;
3. Review the history and evolution of these materials in dentistry;
4. Review our current knowledge regarding selected physical property attributes of these materials;
5. Explain the definition of "bioactivity" in the context of these materials, review research regarding understanding the property of "bioactivity," and consider how it may relate to restorative dentistry;
6. Review current documented clinical findings and evidenced-base literature information regarding these materials as it relates to their properties and use in dentistry; and
7. Future directions and conclusions.

Generations of biomaterials



MTA:

Mineral Trioxide Aggregate, was investigated by the research pioneer and Endodontist, **Dr.Mahmoud Torabinejad,** at Loma Linda university, along with his patient Dean White in 1993. MTA is a powder consisting of fine hydrophilic particles of tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. It also contains small amounts of other mineral oxides, which modify its chemical and physical properties. This is a material of choice for vital pulp therapy, apexification and apexogenesis, correcting procedural errors as well as for root-end filling material in apicoectomy procedures. It has got advantages like alkaline pH, high compressive strength, hydrophilic in nature, minimal or no leakage, biocompatible in nature, antibacterial, undergo cementogenesis.[4]

Biodentine:

As MTA has got some disadvantages like diffficult handling characteristics, long setting time and high material cost new material came into existence in 2011,was introduced by Septodont (SaintMaur des

Fosses- France). The composition of Biodentine is that powder component of the material consists of tricalcium silicate, dicalcium silicate, calcium carbonate and oxide filler,iron oxide shade, and zirconium oxide. Tricalcium silicate and dicalcium silicate are indicated as main and second core materials, respectively, whereas zirconium oxide serves as a radiopacifier. The liquid, on the other hand, contains calcium chloride as an accelerator and a hydrosoluble polymer that serves as a water reducing agent. It has also been stated that fast setting time, one unique characteristics of the product, is achieved by increasing particle size, adding calcium chloride to the liquid component, and decreasing the liquid content. The setting period of the material is as short as 9–12 minutes. Biodentine has been advocated to be used in various clinical applications, such as root perforations, apexification, resorptions, retrograde fillings, pulp capping procedures, and dentine replacement.[1]

Bioactive Glass:

Hench was the first todevelop bioactive glasses(1969) and these glasses were able to bond to the tissues. bioactive glasses have different families and each family has a different composition. Some classes of bioactive glasses as bioactive^{TM} (45S5), are now being used intraorally as bone grafting material. 45S5 bioactive glass is composed of SiO2(46.1 mol%), CaO(26.9 mol%), Na2O(24.4mol%) and P2o5(2.6mol%). 45S5 is able to form hydroxycarbonated apatite in less than 2 hours and binds to tissues. bioactive glasses have a wide range of applications. Bioglass^{TM} also known as 45S5 is most commonly used for bone grafts. It helps in the repair of hard tissues and vrious compositions are being used nowadays for preparation of scaffolds and as coating material for implants. in addition to remineralization, bioactive glasses have antibacterial effects.[5]

Bioceramics:

Bioceramics are exceedingly biocompatible, non–toxic, do not shrink, and are chemically stable within the biological environment. Additionally, and this is very important in endodontics, bioceramics will not result in a significant inflammatory response if an over fill occurs during the obturation process or in a root repair.[6]

II. Conclusion:

Bioactive materials can be considered as boon to dentistry because of its regeneration potential.[2] Thus in the near future it can be envisioned that there will be better alternatives in the field of restorative dentistry in the form of bioactive and biomimetic materials. New mechanisms for adhesion, integration, and sealing of dentin are in the works using bioactive and biomimetic technologies. These materials will behave more like natural teeth and will change the way we think about restoring teeth.[7]

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