



BIOMIMETIC AGENTS IN PERIODONTOLOGY

Periodontology

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ABSTRACT

Periodontitis is an inflammatory condition that damages soft tissues and induces periodontium destruction. Tissue engineering is an interdisciplinary field, which advanced from the development of biomaterials to restore or maintain the function of impaired tissue or organ. Biomimetics in dentistry is an upcoming area of interest, research and development. It is the field of study that attempts to design system and synthesize materials through biomimicry. Today, the emergence of biologics, agents that stimulate a true regeneration and reconstruction of the tissues to their original form, are becoming the new horizon in periodontics.

KEYWORDS

Biomimicry, Biomimetics, Tissue engineering

INTRODUCTION

Biologic agents are substances made from a living organism or its products used in the prevention, diagnosis, or treatment of a disease. In the past, we had agents which facilitated healing but offered minimal osseointegrative effects such as demineralized freeze-dried bone allograft and platelet-rich plasma, which offer low levels of bone morphogenic proteins and low levels of platelet-derived growth factors, respectively. However, the levels offered by these substances, in most cases, are too low to truly induce regeneration, even though both may facilitate bone healing by being osseointegrative and mechanically improving the wound healing. The word “*bios*” meaning life and “*mimesis*” meaning to copy. In 1969, **Otto H. Schmitt**, a biomedical engineer, coined the term “biomimetics”. Biomimetics can be defined as the study of the structure, formation, function of biologically produced materials, biological mechanisms and processes especially for the purpose of synthesizing similar products by artificial mechanisms which mimic natural ones¹. To facilitate rapid vascularization and progressive replacement of newly formed tissue, it should be- Compatible, Resorbable and Porous². The requisite pore size for ingrowth of bone is 150–500 µm and to stimulate fibrovascular growth, the pore diameter should be more than 100 µm^{3,4}.

CLASSIFICATION

According to materials used-

- 1. Ceramics-** calcium phosphate, calcium sulfate, bioactive glass.
- 2. Polymers-** Chitosan, collagen, gelatin, polyglycolic acid, polycaprolactone, and poly-L-lactic acid
- 3. Metal-** 316L stainless steel, commercially pure titanium alloys and titanium alloys, cobalt–chromium alloys.

According to activity⁵

- 1. Osteoconductive:** provide scaffold or framework that supports bone growth and encourages the ingrowth of surrounding bone
- 2. Osteoinductive:** comprising of combination of growth regulatory molecules with carriers
- 3. Osteogenic biomaterials** which contain osteocompetent cells

According to the tissue response⁶⁻

- 1. Bioinert:** Any material which has minimal interaction with its surrounding tissue when placed in the human body. Eg. stainless steel, titanium, alumina, partially stabilized zirconia, and ultra-high-molecular-weight polyethylene
- 2. Bioresorbable:** A material which starts to dissolve upon placement within the human body and is slowly replaced by advancing tissue Eg. tricalcium phosphate (TCP), polylactic–polyglycolic acid copolymers, and gypsum
- 3. Bioactive:** A material which upon being placed within the human body, interacts with the surrounding bone and, in some cases, even soft tissue. There is formation of a Carbonate Hydroxyapatite layer on the implant, which is equivalent to mineral phase of bone Eg. synthetic hydroxyapatite (HA) and bioglass.

Biomimetics Used In Periodontal Surgery

- 1. Bioactive glass:** Perioglass
- 2. Biocompatible ceramics:** Cercon XT, Cercon HT

- 3. Enamel matrix derivative or Emdogain** (Stumann Biologics, Boston)
- 4. Recombinant human platelet-derived growth factors or GEN21F** (Osteohealth Co., Shirley, N.Y.)
- 5. Casein phosphopeptide amorphous calcium phosphate (CPP-ACP)**
- 6. Demineralized dentin:** Biodentine (Septodont, France)
- 7. Growth Factors** –Platelet Derived Growth Factor, Vascular Endothelial Growth Factor, Transforming Growth Factor, Fibroblast Growth Factor, Recombinant human platelet-derived growth factors or GEN21F (Osteohealth Co., Shirley, N.Y.)
- 8. Bone Morphogenic Proteins (BMP)**
- 9. Platelet Concentrates**
- 10. Barrier membranes:** Non-Resorbable (Cellulose acetate (Millipore), E-PTFE with/without Titanium replacement, D(dense)-PTFE, Ti-d-PTFE (Titanium reinforced high density PTFE: Poly TetraFluroEthane) and Resorbable (Collagen, glutaraldehyde, 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide, polyepoxy, diphenylphosphorylationazide)
- 11. 3D scaffolds:** Hydrogels, nano fibrous scaffolds, nano/micro spheres multiphase scaffolds.
- 12. Smart Materials⁷:** highly responsive and have the inherent capability to sense and react according to changes in the environment. Can be Active and passive Eg. **Hydrogel, CerCon, Smart Dentin Replacement, Smart suture**
- 13. Isolagen (Fibrocell Technologies, USA):** Autologous Cell Therapy product composed of a suspension of cultured fibroblasts derived from the patient's own skin.
- 14. PepGen 15 (Ceramid Dental): anorganic bovine derived material (ABM)** that mimics the inorganic component of autogeneous bone and a **synthetic peptide P-15** that mimics the organic component (Type I collagen) of autogeneous bone
- 15. Teriparatide hormone: Made up of 34 amino acids of parathyroid hormone**
- 16. Atrisorb (Atrix Lab, USA):** synthetic, bioabsorbable liquid polymer consists of a poly (DL lactide) PLA dissolved in N-methyl-2-pyrrolidone
- 17. Smart Dentin Replacement:** SDR is a first flowable composite material, characterized by low polymerization stress, low polymerization shrinkage, high depth of cure
- 18. Polyhedral Oligomeric Silsesquioxanes (POSS)⁷**

APPLICATIONS IN PERIODONTAL SURGERIES

- 1. Oral Soft Tissue Wound Healing:** Repair versus Regeneration using barrier membranes, growth differentiation factors, bone grafts etc
- 2. Osseointegration around the Dental Implant.**
- 3. Current Technologies and Applications with a Biomimetic Approach** like Extracellular matrix proteins (Collagen, Fibronectin) and surface modification of a dental implant⁸

CONCLUSION

With the arrival of technology, during the last two decades, numerous changes have been made in the field of Periodontology. This article reviews the various biomimetic materials and its biological properties in the field of periodontics. It is the designing of biomaterials that simulates physical and mechanical properties of the lost tissue, thus providing an opportunity to introduce and change treatment modalities for the disease. The biomimetic approach seems promising and

enhances the biomaterial research with previous achievement in the tissue regeneration field. Although some progress has been observed in the reconstruction of periodontal tissue and alveolar bone defects over the past decade, further biomimetic studies are still needed to challenge the current problems for clinical application. The selected biomimetic approach involves the design of a biomaterial to which the host biological system could respond in a more favorable and effective manner, providing an exciting new era for the research and development of biomaterials.

REFERENCES

1. Kottor J. Biomimetic endodontics. Barriers and strategies. *Health Sci* 2013;2:JS007.
2. Hannouche D, Petite H, Sedel L. Current trends in the enhancement of fracture healing. *J Bone Joint Surg Br* 2001;83:157-64.
3. Brydone AS, Meek D, Maclaine S. Bone grafting, orthopaedic biomaterials, and the clinical need for bone engineering. *Proc Inst Mech Eng H* 2010;224:1329-43.
4. Parikh SN. Bone graft substitutes: Past, present, future. *J Postgrad Med* 2002;48:142-8.
5. Darby I. Periodontal materials. *Australian Dental Journal* 2011;56 Suppl 1:107-18.
6. Rai and Kalantharakath: Biomimetic materials-periodontal regenerative materials inspired from nature; *Journal of International Society of Preventive and Community Dentistry*; December 2014, Vol. 4, Supplement 2
7. Ali A et al; Biomimetic Materials in Dentistry; Research & Reviews: *Journal of Material Sciences*; DOI: 10.4172/2321-6212.1000188
8. Cho et al; An Overview of Biomaterials in Periodontology and Implant Dentistry; Hindawi; *Advances in Materials Science and Engineering* Volume 2017, Article ID 1948241, 7 pages; <https://doi.org/10.1155/2017/1948241>.