Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 07(G), pp. 33742-33744, July, 2019

ISSN: 0976-3031

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

CEMENTUM IN PERIODONTAL REGENERATION-STRATEGIES AND APPROACHES

Balaji Ganesh. S., Anilkumar. K., Jaideep Mahendra*., Geetha. A and Ambalavanan. N

Department of Periodontics, Faculty of Dentistry, Meenakshi Academy of Higher Education and Research, Chennai, Tamilnadu, India

DOI: http://dx.doi.org/10.24327/ijrsr.2019.1007.3739

ARTICLE INFO

Article History:

Received 13th April, 2019
Received in revised form 11th May, 2019
Accepted 8th June, 2019
Published online 28th July, 2019

Key Words:

Dental cementum, periodontal regeneration, enamel matrix proteins, molecular factors in regeneration.

ABSTRACT

The distinctive anatomy and composition of the periodontium make periodontal tissue healing and regeneration a complex process. Periodontal regeneration aims to recapitulate the crucial stages of wound healing associated with periodontal development in order to restore lost tissues to their original form and function and for regeneration to occur, healing events must progress in an ordered and programmed sequence both temporally and spatially, replicating key developmental events. Various procedures are employed to promote true and predictable regeneration of the periodontium. Principally, the approaches are based on the use of graft materials and barrier membranes for guided tissue regeneration and use of various bioactive molecules. For new cementum and attachment formation during periodontal regeneration, the local environment must be conducive for the recruitment and function of cementum-forming cells, and that the wound matrix is favorable for repair rather than regeneration.

INTRODUCTION

Periodontal regeneration can be defined as the complete restoration of the lost tissues to their original architecture and function by recapulating the crucial wound healing events associated with their development. Cementum is the mineralized dental tissue covering the anatomic roots of human teeth. After the periodontal therapy, major changes occur only in the epithelium and connective tissue but not in the cementum. Various phases of wound healing in the periodontal therapy include blood clot formation, reepithelialization at the wound margin, angiogenesis and collagen synthesis and remodeling phase. Regeneration of periodontium requires the reestablishment of alveolar bone height to the original position at the cementoenamel junction and the formation of acellular extrinsic fiber cementum on the previously exposed root surface.[1] The local environment for regeneration should be conducive for the recruitment and functioning of cells forming cementum. The wound matrix that is formed, favours repair rather than regeneration. One major goal of regenerative periodontal therapy is new cementum formation and restoration of soft-tissue attachment to the cementum. New therapeutic approaches include guided tissue regeneration, application of growth factors and nanomatrix proteins to the root surface. However the formation of cementum remains unpredictable.

Role of Molecular Factors in Regeneration

According to Melcher (1985), only periodontal ligament cells have progenitor cells or stem cells that have the capability to differentiate into cementoblast, osteoblast and fibroblast.[2] They are found to be depleted or absent during the process of tissue destruction. The molecular factors responsible for recruiting and differentiating these cells like chemotactic factors, adhesion molecules, growth factors and matrix constituents which are found only in the cementum are also depleted. Hence microenvironment of cementum contains all the components necessary for cell recruitment, proliferation and differentiation during periodontal regeneration. Alteration of this microenvironment happens during periodontal destruction. Several biologically active mediators have been reviewed by various investigators which prove to facilitate in periodontal regeneration. The existing periodontal ligament is the only tissue comprising of precursor cells or progenitor cells. The local environment provides the instructions and the stimulating signals for these cells to differentiate. The extracellular matrix and the growth factors present in extracellular matrix and substances present in circulation play a pivotal role in providing stimulus and directional signals for the cells to migrate. Insulin like growth factor - 1, fibroblast growth factor, platelet derived growth factor and connective tissue growth factor are involved in proliferation, differentiation and matrix synthesis. Transforming growth factor – ß is needed for matrix

Corresponding author:* **Jaideep Mahendra
Department of Periodontics, Faculty of Dentistry, Meenakshi Academy of Higher Education and Research, Chennai, Tamilnadu, India

synthesis, angiogenesis, chemotaxis. Bone morphogenetic proteins play a role in matrix synthesis, differentiation and bone formation. Cementum attachment proteins and bone sialoprotein play a role in cell adhesion, differentiation and mineralization. Osteopontin, fibronectin and osteonectin regulates cell adhesion and differentiation.

Role of Extracellular Matrix in Regeneration

Extracellular matrix is a three dimensional matrix and has collagen, fibronectin, elastin, other non collagenous proteins and proteoglycan as their contents. They act as substrate for cell adhesion and promotes spreading of cells and organization of cytoskeleton. They determine the development of 3 dimensional structures, regulate gene expression of growth factor and its receptors and also determine the outcome of cell response to growth factors. It can induce signaling pathway which controls the biological function.[3] Binding the cells to extracellular matrix requires the help of integrins and this binding can initiate a cascade of signaling process. Expressions of integrins and growth factors induced signals, which are important for the expression of G_1 Cyclins and cell cycle progression from G_0/G_1 to S phase. Extracellular matrix induces a sustained increase in activity of integrins and growth factor induced signaling pathways by formation of mitogen activated protein kinases as well as activation of extracellular signal regulated kinases 1 and 2 (ERK1/2) resulting in increased cyclin D_1 expression. Extracellular matrix components are indeed expressed during periodontal healing however, whether all molecules present in cementum matrix are expressed is not known. The temporal sequence of their expression is also important for initiating new cementum formation.[4] These factors may explain why cementum regeneration is not always predictable for the available regenerative procedures. During inflammation and wound healing response following periodontal surgery, a group of growth factors is available from both the circulatory and inflammatory cells. The provisional matrix formed by blood clot and granulation tissue has a composition different from that of the cementum environment under healthy conditions. This combination of growth factors and extracellular matrix is not likely to be conductive to the selection and function of cementoblast progenitors. If progenitors are not present and only stem cells are available, their differentiation to cementoblasts may require that events during early cementogenesis be recapitulated, and needed signaling molecules are not likely to be available in the wound-healing environment. Thus, it appears essential that the right combination of extracellular matrix components and growth factors is necessary to induce new cementum formation.[1] One factor that needs to be considered is that, in early and moderate periodontitis, acellular cementum (coronal half of the root) is affected, and the damage extends to cellular cementum in most advanced and furcally positioned lesions. These surfaces are almost always covered by cellular cementum during successful regeneration.[5] The growth factors and adhesion molecules present in cementum are also active toward cells of the gingiva, periodontal ligament, and alveolar bone. Therefore, it is possible that cementum components have the potential to participate in the regulation of homeostasis and regeneration of these tissues.

Strategies for Periodontal Regeneration / Repair

Success of periodontal healing relies in reconstruction of destroyed components of periodontium which includes the alveolar bone, cementum and the periodontal ligament. The tissue engineering concept of regeneration stresses in the three component of the triad: cells, growth factors and scaffold. The process of periodontal tissue regeneration starts at the moment of tissue damage by means of growth factors and cytokines released by the damaged connective tissue and inflammatory cells. It is well accepted that in order to improve periodontal healing, root planing or root conditioning is a necessary antecedent to mesenchymal cell migration and attachment onto the exposed root surface.[6] Acid treatment, in particular with citric acid, has been found to widen the orifices of dentinal tubules, thereby accelerating cementogenesis and increasing cementum apposition and connective tissue attachment.

Guided Tissue Regeneration and Bone Grafting In Cementum Regeneration

Nyman *et al* (1982) using millipore membranes, introduced the concept of a membrane barrier, which excludes the apical migration of gingival epithelial cells and provides an isolated space for the inwards migration of periodontal ligament cells, osteoblasts and cementoblasts.[7] It has also been questioned whether guided tissue regeneration produces true cementum regeneration or only cemental repair. The newly formed cementum has been characterized as a cellular cementum that is usually poorly attached to the dentin surface. It is suggested that periodontal healing with guided tissue regeneration therapy occurs in two stages. The first stage comprises an initial healing phase with the formation of a blood clot, transient root resorption/demineralization, deposition of acellular cementum on the root surface and formation of connective tissue. The second phase comprises a remodeling process, which will result in a regenerated cementum similar to pristine cementum as maturation proceeds over time.[8]

Molecular Approaches for Cementum Regeneration

It is suggested that growth factor molecules are produced during cementum formation and then stored in the mature cementum matrix with the potential to induce periodontal repair or regeneration when needed. Amongst the growth factors currently being used are platelet derived growth factor, insulin like growth factor, transforming growth factor β1, basic fibroblast growth factor, and bone morphogenetic proteins. However, problems in applying these growth factors for periodontal repair include the nonspecific activity of some factors on different cell lineages in time and space, and the rapid loss of growth factors applied topically. When platelet derived growth factor was used in combination with bone allografts to treat Class II furcations and interproximal intrabony defects, histological evaluation showed regeneration of new alveolar bone, cementum, and periodontal ligament.[9] Recently, it was shown that the application of a synthetic BMP-6 polypeptide to a periodontal fenestration defect in rats resulted in increased formation of new bone and cementum.[10]

Enamel Matrix Proteins in Cementum Regeneration

Based on the presence of enamel proteins in acellular cementum, it was thought that these proteins may play a role in the repair/regeneration of periodontal tissues destroyed by periodontal disease. Animal histological studies with surgically created defects suggest that enamel matrix derivative induces the formation of acellular cementum and promotes attachment of the supporting periodontal tissues, human histological studies have questioned both the consistency of the histological outcomes and the ability of enamel matrix derivative to predictably stimulate the formation of acellular cementum. It appears that following treatment with enamel matrix derivative, a bone-like tissue resembling acellular extrinsic fibrous cementum is formed.[11]

Stem Cells in Cementum Regeneration

Regeneration dentistry, in particular that using somatic stem cells has received a considerable amount of attention in recent years in the field of periodontics. In a study, periapical follicle stem cells isolated from the apical end of developing root of human third molars at the root-developing stage was evaluated for the potential application in bio-root engineering. It was showed the periapical folicle stem cells have tissue regenerative capacity to produce a typical cementum/ periodontal ligament complex in vivo.[12] Thus, the future of cementum regeneration will be stem cell based therapies.

CONCLUSION

Thus cementum is a highly responsive mineralised tissue, which maintains the integrity of the root and sustains the tooth in its functional position in the mouth, and is also involved in tooth repair and regeneration. Many of the regenerative approaches reviewed are still under assessment and further research is needed to develop cell-based tissue strategies, perhaps using stem cells and biomaterials for delivery of these cells. Conceivably, the future application of cementum-derived growth or attachment factors may result in accelerated wound healing and in controlled neocementogenesis following periodontal regenerative surgery.

References

1. Grzesik WJ, Narayanan AS. Cementum and periodontal wound healing and regeneration. *Crit Rev Oral Biol Med* 2002; 13(6):474-84.
2. Melcher AH. Cells of periodontium: Their role in the healing of wounds. *Ann R Coll Surg Engl* 1985; 67:130-131.
3. Adams JC, Watt FM. Regulation of development and differentiation by the extracellular matrix. *Development* 1993; 117:1183-1198.
4. Ivanovski S, Li H, Daley T, Bartold PM. An immunohistochemical study of matrix molecules associated with barrier membrane-mediated periodontal wound healing. *J Periodontal Res* 2000;35(3):115-126.
5. MacNeil RL, Somerman MJ. Development and regeneration of the periodontium: Parallels and contrasts. *Periodontol 2000* 1999;19:8-20.
6. Narayanan AS, Bartold PM. Biochemistry of periodontal connective tissues and their regeneration: A current perspective. *Connect Tissue Res* 1996; 34:191-201.
7. Nyman S, Gottlow J, Karring T, Lindhe J. The regenerative potential of the periodontal ligament. An experimental study in the monkey. *J Clin Periodontol* 1982;9(3):257-265.
8. Graziani F, Laurell L, Tonetti M, Gottlow J, Berglundh T. Periodontal wound healing following GTR therapy of dehiscence type defects in the monkey: short, medium and long-term healing. *J Clin Periodontol* 2005; 32:905-914.
9. Camelo M, Nevins ML, Schenk RK, Lynch SE, Nevins M. Periodontal regeneration in human Class II furcations using purified recombinant human platelet-derived growth factor-BB (rhPDGF-BB) with bone allograft. *Int J Periodontics Restorative Dent* 2003; 23:213-225.
10. Huang KK, Shen C, Chiang CY, Hsieh YD, Fu EJ. Effects of bone morphogenetic protein 6 on periodontal wound healing in a fenestration defect of rats. *J Periodontal Res* 2005; 40:1-10.
11. Kalpidis CD, Ruben MP. Treatment of intrabony periodontal defects with enamel matrix derivative: A literature review. *J Periodontol* 2002; 73:1360-1376.
12. Han C, Yang Z, Zhou W *et al*. Periapical follicle stem cell: a promising candidate for cementum/periodontal ligament regeneration and bio-root engineering. *Stem Cells Dev* 2010; 19:1405-1415.

How to cite this article:

Balaji Ganesh. S *et al*.2019, Cementum In Periodontal Regeneration-Strategies And Approaches. *Int J Recent Sci Res.* 10(07), pp.33742-33744. DOI: http://dx.doi.org/10.24327/ijrsr.2019.1007.3739

****