International Journal of Research in Health and Allied Sciences

Journal home page: www.ijrhas.com

Official Publication of "*Society for Scientific Research and Studies*" [Regd.]

ISSN 2455-7803 Index Copernicus value 2016 = 68.10

Review Article

Stem Cell for Periodontal Regeneration

[1]Neha Singh Sikarwar, [2]Pankaj Malhotra, [3]Kriti Mainali, [4]Sangeeta Payasi, [5]Poorva Bain

[1]PG student, [2]Professor & HOD, Department of Periodontology, [3]PG student, Department Of Pedodontics and Preventive Dentistry, Maharana Pratap College Of Dentistry & Research Centre, Gwalior, MP, India, [5]Department of Conservative Dentistry and Endodontics, [4]Department Of Pedodontics and Preventive Dentistry. Triveni Institute Of Dental Sciences Hospital & Research Centre Bilaspur, Chhattisgarh

***ABSTRACT*:**
Gingivitis and periodontitis are infectious diseases that affect a high percentage of the population, even at younger ages.Stem cells have the ability to build every tissue in the human body, hence have great potential for future therapeutic uses in tissue regeneration and repair. Hence; in the present review, we have summarized the role of stem cells in periodontal regeneration.
Key words: Periodontal, Regeneration, Stem cells.

Received: 5 January 2019 Revised: 25 January 2019 Accepted: 28 January 2019

Corresponding author: Dr. Neha Singh Sikarwar, PG student, Department of Periodontology, Maharana Pratap College Of Dentistry & Research Centre, Gwalior, MP, India

This article may be cited as: Sikarwar NS, Malhotra P, Mainali K, Payasi S, Bain P. Stem Cell for Periodontal Regeneration. Int J Res Health Allied Sci 2019; 5(1):69 -71.

INTRODUCTION

The periodontium is a complex organ consisting of two soft connective tissues (gingival and periodontal ligament) and two hard connective tissues (cementum and alveolar bone). The periodontal diseases are a diverse group of clinical entities in which induction of an inflammatory process results in destruction of the attachment apparatus, loss of supporting alveolar bone, and, if untreated, tooth loss.[1-3] Periodontitis is defined as an inflammatory disease of supporting tissues of teeth caused by specific microorganisms or groups of specific microorganisms, resulting in progressive destruction of the periodontal ligament and alveolar bone with periodontal pocket formation, gingival recession or both. The significant burden of periodontal disease and its impact on general health and patient quality of life point to the need for more effective management of the condition.[4]Once damaged, the periodontium has a limited capacity for regeneration. During the early phases of the disease, some minor regeneration of the periodontium may be seen. Advances in stem cell biology and regenerative medicine have presented opportunities for tissue engineering and gene-based approaches in periodontal therapy. Stem cell-based tissue engineering raised novel therapeutic strategies for tooth and periodontal repair.[5]Hence; we aim to summarize role of stem cells in periodontal regeneration.

Stem Cells

The general designation, "stem cell" encompasses many distinct cell types. Commonly, the modifiers, "embryonic," and "adult" are used to distinguish stem cells by the developmental stage of the animal from which they come, but these terms are becoming insufficient as new research has discovered how to turn fully differentiated adult cells back into embryonic stem cells and, conversely, adult stem cells, more correctly termed "somatic" stem cells meaning "from the body", are found in the fetus, placenta, umbilical cord blood and infants. Stem cells are divided into two categories based on their biologic properties - pluripotent stem cells and multipotent stem cells.[5]

Since Federal funding for human embryonic stem cells is restricted in the United States, many scientists use the mouse model instead. Besides their ability to self-renew indefinitely and differentiate into cell types of all three germ layers, murine and human pluripotent stem cells have much in common. It should not be surprising that so many pluripotency traits are conserved between species given the shared genomic sequences and intra-cellular structure in mammals. Both mouse and human cells proliferate indefinitely in culture, have a high nucleus to cytoplasm ratio, need the support of growth factors derived from other live cells, and display similar surface antigens, transcription factors and enzymatic activity (i.e. high alkaline phosphatase activity).[6, 7]

Periodontal disease occurs when a bacterial biofilm (dental plaque) adheres to the boundary between the teeth and gingiva, causing chronic inflammation and progressively destroying the periodontal tissue that supports the teeth. Therefore, periodontal treatment involves scaling and root planing, which mechanically removes the causative bacteria biofilm together with the necrotic cementum from the surface of the tooth root. Appropriate application of this therapy eliminates periodontal tissue inflammation and stops the process of destruction of the same tissue. However, removing the cause of the disease does not regenerate the lost periodontal tissue to its original state. Given the high prevalence of periodontal disease both in Japan and worldwide and the need to maintain or enhance "QOL supported by the teeth and the mouth" in middle-aged and elderly people, developing highly predictable periodontal tissue regenerative therapy that can be performed as a follow-on after treatment to remove the cause is urgently needed.[8]

Periodontal regeneration

Regeneration of the attachment apparatus destroyed because of periodontitis has long been the goal of periodontal therapy. Periodontal regeneration can be defined as the complete restoration of the lost tissues to their original architecture and function by recapitulating the crucial wound healing events associated with their development. The requirements for periodontal regeneration include the simultaneous regeneration of cementum, the periodontal ligament and alveolar bone.[9]

Current status of periodontal tissue regenerative therapy

Although mesenchymal stem cells that can differentiate into osteoblasts and cementoblasts are present in the adult periodontal ligament, periodontal tissue does not successfully regenerate when conventional periodontal treatment is performed to remove the cause of periodontal disease. Thus, in addition to conventional treatment, it is necessary to develop a method for inducing the periodontal tissue stem cells present in the periodontal ligament.[10]

Possibility of periodontal tissue regenerative therapy with stem cell transplantation

The periodontal tissue regenerative therapy described above promotes the regeneration of periodontal tissue by inducing the functions of stem cells present in all periodontal ligaments. However, the number of stem cells in periodontal ligament decreases with age. Therefore, in elderly people and in cases of severe periodontal disease, we do not expect an adequate amount of regeneration simply by activating the stem cells present in the periodontal ligament. In these cases, it may be necessary to promote periodontal tissue regeneration by transplanting mesenchymal stem cells collected from other tissue in the same patient to the site of periodontal tissue loss.[11]

The use of induced pluripotent stem cells is expected in the future, but it will still be some time before this technology can be clinically applied in the field of dentistry. However, it has been clarified that undifferentiated mesenchymal stem cells are present in a variety of tissues in our bodies, even after reaching adulthood. Studies are currently being conducted to regenerate periodontal tissue by transplanting stem cells collected from these tissues into the site of periodontal tissue loss together with suitable scaffolding materials.[12]

Both extraoral and intraoral tissues have stem cell populations that represent a viable and accessible alternative source to harvest and expand multipotent colonies for potential use in periodontal tissue engineering. MSCs derived from multiple tissue sources have been investigated in preclinical animal studies for the treatment and regeneration of the periodontium.[12]

In-vivo differentiation capacity of periodontal ligament stem cells

There has been a considerable amount of research conducted to assess the regenerative capacity of PDLSCs in a range of dental and craniofacial defects in various animal models. It is evident from these studies that implanted PDLSCs generate cementum and periodontal ligament-like structures similar to native periodontal complex.[13]

Conventional periodontal therapy involves debridement of the root surface to induce healing, guided tissue regeneration, and bone graft placement. Indeed, the traditional treatment for periodontitis is associated with a relatively high degree of variability in clinical outcome, and the curative effect remains unsatisfactory. The advances in regenerative medicine have made it possible for periodontal regeneration based on MSC-mediated tissue engineering. Among all the mesenchymal stem cells, PDLSCs are the main candidate stem cells in periodontal regeneration. Transplanting PDLSCs directly into periodontal defect areas resulted in periodontal regeneration. When transplanted into surgically created periodontal defect areas in miniature pigs, autologous and allogeneic PDLSCs also were capable of regenerating periodontal tissues, indicating PDLSC-mediated tissue engineering could be a useful treatment for periodontitis. The potential mechanism has also been clarified and is largely dependent on the immunomodulatory properties of PDLSCs. These cells possess low immunogenicity and remarkable immunosuppression via secreting prostaglandin E2 (PGE2), leading to PGE2-induced T-cell anergy.[14]

Results of implantation of bone marrow stem cells into dental defects

Bone marrow stem cells have been extensively studied with regard to their capacity to aid periodontal regeneration. Bone marrow stem cells have the capacity

to enhance periodontal regeneration through enhanced generation of well-formed mature alveolar bone and neovascularization. Furthermore, transplanted bone marrow stem cells contributed to the formation of new cementum and periodontal ligament.[14]
Whilst bone marrow stem cells have proven that they have the capacity to regenerate periodontal tissues, the difficulty associated with the isolation of bone marrow stem cells means that moving forward it is going to be challenging to use this cell population in periodontal regeneration in the clinical setting. In light of this, researchers have begun to assess whether it would be possible to use dental-derived mesenchymal stem cell-like stem cell populations in periodontal regeneration. These stem cell populations have the advantage over bone marrow stem cells that they can be obtained from patients in the dental clinic rather than requiring an invasive bone marrow aspiration procedure at a secondary clinic.[14]

Biological challenges

Despite biological evidence that periodontal regeneration can occur in humans, complete and predictable regeneration remains an exclusive clinical goal and the molecular processes that underlie stem cell proliferation and differentiation are largely unknown. Thus, future research efforts might be focused on the potential use of this cell population in tissue engineering and in their maintenance and differentiation in *vitro* and in *vivo*.[14]

Future clinical applications of stem cell research

Discovering how the pluripotent state can be efficiently and stably induced and maintained by treating cells with pharmacologically active compounds rather than by genetic manipulation is an important goal. Thus stem cell-based assays are already enhancing drug discovery efforts.

REFERENCES

1. Han J, Menicanin D, Gronthos S, Bartold PM. Stem cells, tissue engineering and periodontal regeneration. Australian Dental Journal 2014; 59:(1 Suppl): 117–130.
2. Alison MR1, Poulsom R, Forbes S, Wright NA. An introduction to stem cells. J Pathol. 2002 Jul;197(4):419-23.
3. Weiner LP. Definitions and criteria for stem cells. Methods Mol Biol. 2008;438:3-8. doi: 10.1007/978-1-59745-133-8_1.
4. Watt FM, Driskell RR. The therapeutic potential of stem cells. Philosophical Transactions of the Royal Society B: Biological Sciences. 2010;365(1537):155-163.
5. Biehl JK, Russell B. Introduction to Stem Cell Therapy. The Journal of cardiovascular nursing. 2009;24(2):98-105
6. Bajada S, Mazakova I, Richardson JB, Ashammakhi N. Updates on stem cells and their application in regenerative medicine. J Tissue EngRegen Med. 2008;2(4):169–83.
7. Aoi T, Yae K, Nakagawa M, et al. Generation of pluripotent stem cells from adult mouse liver and stomach cells. Science. 2008 Epub ahead of print.
8. Nakagawa M, Koyanagi M, Tanabe K, et al. Generation of induced pluripotent stem cells without Myc from mouse and human fibroblasts. Nature Biotech. 2008;26(1):101–106.
9. Aoi T., Yae K., Nakagawa M., Ichisaka T., Okita K., Takahashi K., Chiba T., Yamanaka S. 2008Generation of pluripotent stem cells from adult mouse liver and stomach cells. Science 321, 699–702.
10. Mudda JA, Bajaj M. Stem cell therapy: A challenge to periodontist. Indian J Dent Res 2011;22:132-9.
11. Takayama S, Murakami S, Shimabukuro Y, Kitamura M, Okada H. Periodontal regeneration by FGF-2 (bFGF) in primate models. J Dent Res. 2001;81:2075–9.
12. Kim SH1, Kim KH, Seo BM, Koo KT, Kim TI, Seol YJ, Ku Y, Rhyu IC, Chung CP, Lee YM. Alveolar bone regeneration by transplantation of periodontal ligament stem cells and bone marrow stem cells in a canine peri-implant defect model: a pilot study. J Periodontol. 2009 Nov;80(11):1815-23.
13. Gonçalves F1, de Moraes MS2, Ferreira LB3, Carreira AC4, Kossugue PM4, Boaro LC3, Bentini R1, Garcia CR2, Sogayar MC4,5, Arana-Chavez VE3, Catalani LH1. Combination of Bioactive Polymeric Membranes and Stem Cells for Periodontal Regeneration: In Vitro and In Vivo Analyses. PLoS One. 2016 Mar 31;11(3):e0152412.
14. Dabra S, Chhina K, Soni N, Bhatnagar R. Tissue engineering in periodontal regeneration: A brief review. Dental Research Journal. 2012;9(6):671-680.