Volume : 4 | Issue : 8 | Aug 2015 • ISSN No 2277 - 8179

Stem Cells- Hope and Possibilities

DENTAL SCIENCE

KEYWORDS : Regeneration, Stem cells, Dental Stem Cells, Isolation, Epithelial stem cells, Mesenchymal Stem cells, Stem Cell Niche.

Dr. Shalya Raj	Lecturer, Department of Conservative Dentistry And Endodontics Subharti Dental College, NH 58 Bypass Road, Swami Vivekanand Subharti University, Meerut. *Corresponding Author
Dr. Rohit Arora	Lecturer, Department of Conservative Dentistry And Endodontics Subharti Dental College, NH 58 Bypass Road, Swami Vivekanand Subharti University, Meerut.
Dr. Anil Dhingra	Professor and Head, DJ Dental College, B-3, New Multan Nagar, New Delhi-110056

ABSTRACT

The stem cells are the basis of a successful regeneration. Their discovery has served as a boon and gift of God to help us do what only the almighty could- regenerate and replace the lost. Stem cells have given the field of medicine a power to serve our patients better providing them the impossible. It is important to understand these stem cells completely to be able to utilize them completely. These cells have capabilities, characteristics and specific sources which need to be understood. Also their storage and usage is very technique sensitive and procedure specific. The article provides an insight of all the above

INTRODUCTION

The science has presented us with the hope called 'stem cell research' which may provide us with answers which have so long been beyond our grasp. The stem cells are the powerful and unique cells that can multiply several times and depending on the surrounding environment can form specific desired tissue or organ. This has the potential to provide solutions for several uncurable diseases or injuries.

The stem cells research is directed towards perfecting the art of using one's own cells to repair that part of the body which has become affected due to a particular disease. The stem cells by virtue of their properties play an important role in the normal development of the organs, the system and normal day to day repair. One of the major sources of stem cells which are not only economical, procedurally safe, controversy free and ease of harvesting is the dental stem cells. The stem cells can now be harvested, made to multiply, stored and utilized whenever required in future. This is similar to the practice of banking where one deposits money, multiplies it, stores it and hence the term 'stem cell banking'.

STEM CELLS

Stem cells differ from other kinds of cells in the body. All stem cells, regardless of their source, have three general properties: they are capable of dividing and renewing themselves for long periods; they are unspecialized; they can choose to become one of the many different types of cells present in the body based on signals from their environments. Unspecialized stem cells can give rise to side specialized cells including heart muscle cells, blood cells, or nerve cells. They do this by coordinating their gene expression in an elaborate and complex patterning many generations of cells.

Murray PE, Gracia- Godoy F, Hargreaves KM (1) in 2007 defined stem cells as, "a cell that has the ability to continuously divide and produce progeny cells that differentiate (develop) into various other types of cells or tissues".

Bluteau G, Luder H-U et al (2) in 2008, defined stem cells as, "a cell that can reproduce unaltered daughters and, furthermore has the ability to generate cells with different and more restricted properties".

Huysseune A and Thesleff I in 2004 (3) defined them as, "a cell that can divide to produce both daughter stem cells and cells that can go onto differentiate".

Duailibi and Dualibi, 2006 (4) defined stem cells as, "Quiescent cell populations present in low numbers in normal tissue, which exhibit the distinct characteristic of asymmetric cell division, resulting in the formation of two distinct daughter cells - a new progenitor/ stem cell and another daughter cell capable of forming differentiated tissue".

The work that led to the discovery of stem cells was the study of teratocarcinomas, complex tumors containing a mix of specialized cell types as well as a population of unspecialized cells. These unspecialized cells are called embryonal carcinoma (EC) cells. The latter were shown to be pluripotent and could give rise to various cell types both *in vitro* and *in vivo*. The demonstration that ES cells contained the normal number of chromosomes and were truly pluripotential has influenced many scientific disciplines.(Figure 1)

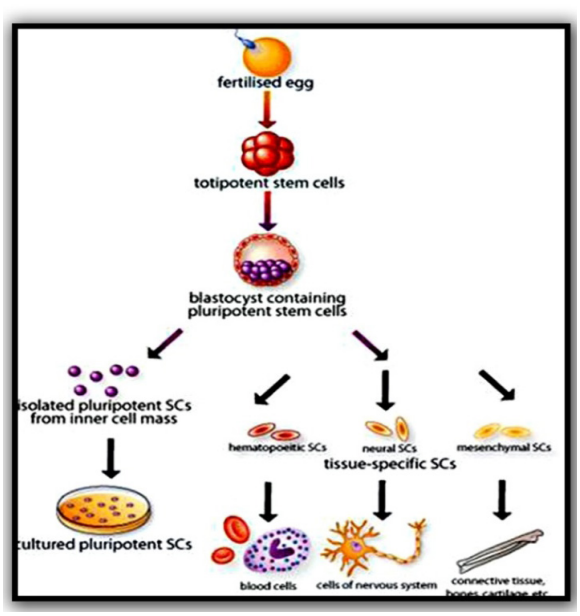

Figure 1: Stem cells derivation

Adult stem cells are quiescent, slow-cycling, undifferentiated cells; surrounded by neighboring cells and extracellular matrix with a side specific compartment. Many adult tissues (such as the bone marrow, brain and gut) contain stem cells. Like ES cells, adult stem cells can make identical copies of themselves for long periods of time (self-renewal). At the same time, they

can give rise to mature cell types that have characteristic shapes and side specialized functions. Stem cells typically generate an intermediate cell type(s) before they achieve their fully differentiated state; called a progenitor cell. These are partly differentiated cells committed to a particular cell lineage and, upon division give rise to differentiated cells.

The stem cells have certain properties[1] which makes them apt for use in regenerative medicine, namely Plasticity: Murray PE, et al2007(1)described it as the ability to produce cells of different tissues; Undifferentiated cells which can respond to appropriate signals; Ability to self replicate; Maintain the multiple differentiations potential: Proliferation properties(Chart 1)

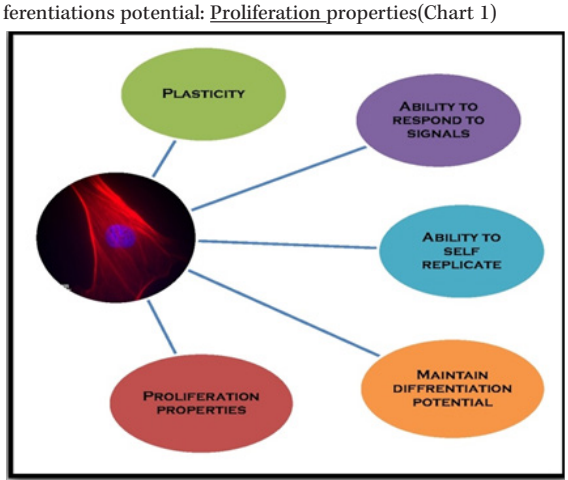

CHART 1: THE STEM CELLS AND ITS PROPERTIES

Stem cells can be obtained from different sources; as per the need and host's condition to best suit the need of the patient to manage the disease. These are; Autologous cells (the host's own cells); Allogenic cells (cells from a donor) ;Xenogenic cells (cells from a different species); *allogenic* (fetal or adult derived) or *autologous* (adult derived); It is often assumed that the use of autologous cells implies minimal manipulation and maximum safety for the host because of the use of the host's own cells. This is not entirely correct as culture processes and reagents can alter cells, regardless of their origin.

Relevance in dentistry : Dental Pulp and Stem Cells

The dentin pulp complex has a natural regenerative potential leading to the formation of tertiary dentin[5,6] Odontoblasts may survive mild injury, such as attrition or early caries, and secrete a reactionary dentin matrix. In cases of trauma of greater intensity the pre existing odontoblasts may die leading to the recruitment and differentiation of new odontoblasts and synthesis of an atubular dentin.

A growing number of studies namely, Gronthos S et al in 2002 (7) Miura M ,Gronthos S et al in 2003 (8) Lui H et al in 2004(9) Smith AJ in 2004 (10) Modino SAC, Sharpe PT in 2005 (11) Iohara K at al 2006 (12) and many more, have indicated that the post natal pulp contains several niches of potential progenitor stem cells which may have a fundamental role in regenerative medicine. Dental mesenchymal progenitor cells have been characterized using transgenic mouse[13]models, porcine models [12,14], chimpanzees[15] and mesenchymal stem/progenitor cells have been identified and characterized in dental pulp obtained from both deciduous[8] and adult human teeth[16,17]. Preliminary characterization of postnatal epithelial and mesenchymal dental stem/progenitor cells present in immature tooth buds demonstrated the ability to generate bioengineered, anatomically correct tooth crowns containing enamel, dentin, pulp and alveolar bone. (Chart 2)

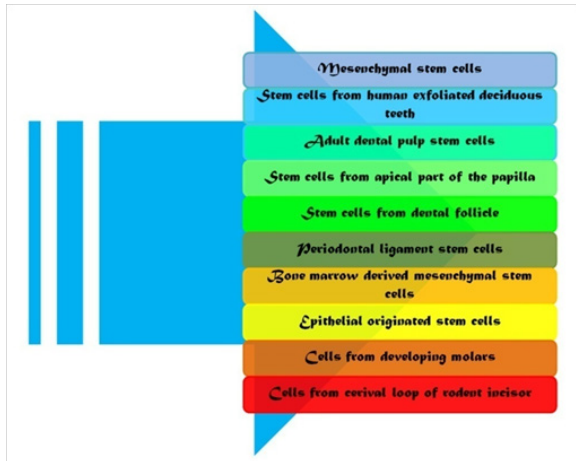

Chart 2: Dental Stem cells

The Stem cell Niches

Adult stem cells are confined within compartments called the niche, defined by Huysseune A and Thesleff I in 2004 (3) as, "the microenvironment that allows stem cells to divide and to give rise to cells perpetuating the stem cell and cells that enter a differentiation pathway". Although most stem cells do not contain known markers which can be used for localization of stem cells in tissues; they reside in specific locations called stem cell niches. Owing to this the progenitor/stem cell niches usually maintain a quiescent state in a healthy state but in case of injury leading to the death of post mitotic cell, a cascade of complexes is released. These signals cause the stem cell population to produce a high proliferative activity.

Thus, tooth engineering using stem cells is based on their isolation, association and culture as recombinants *in vitro* or *ex vivo* conditions to assess firstly tooth morphogenesis and secondly cell differentiation into tooth side specific cells that will form dentin, enamel, cementum and alveolar bone. The side specialized microenvironment, housing adult stem cells and transient amplifying cells (TAC), forms a "niche". As tooth formation results from epithelial-mesenchymal interactions, two different populations of stem cells have to be considered: epithelial stem cells (EpSC), which will give rise to ameloblast, and mesenchymal stem cells (MSC) that will form the odontoblasts, cementoblasts, osteoblasts and fibroblasts of the periodontal ligament.

Identification of stem cells

Yelick PC and Vacanti JP (17) have used two important methods to generate homogenous epithelial and mesenchymal post natal dental stem cell populations for tooth tissue engineering applications. [Honda MJ et al in 2007 (18)]; Use of antibodies: the stem cells were sorted out on the ability of certain antibodies that recognize the antigens; Dye profiling, a Hoechst 33342 dye profiling is done taking advantage of the fact that certain cells exhibit the capacity to efflux the dye whereas non-stem cells retain the dye.

CONCLUSION:

Stem cell research have been widely worked upon, however without understanding the stem cells per se no success is possible.

Stem cells cannot solely give rise to a new tissue, it needs to be coupled with the correct scaffolds and Growth factors. These

Volume : 4 | Issue : 8 | Aug 2015 • ISSN No 2277 - 8179

two also have a wide range of properties and peculiarities which need to be looked into. This can be done using various techniques of tissue regeneration. Time and again success has returned from our doorstep however our struggle to reach the unknown is still on. Knowledge is the solution to all hurdles.s

REFERENCE

1. Murray PE, Godoy-Gracia F. The outlook for implants and endodontics: A review of the tissue engineering strategies to create replacement teeth for patients. DCNA 2006 Apr;50:299-315 | 2. Bluteau G, Luder H-U, Bari C De, Mitsiadis TA. Stem cell for tissue engineering. European Cells and Materials 2008;16:1-9. | 3. Huyssenne A, Thesleff I. Continuous tooth replacement: The possible involvement of epithelial stem cells. Bioessays 2004;26.6:665-71 | 4. Duailibi SE, Dualibi MT, Vacanti JP, Yelick PC. Prospects for tooth regeneration. Periodontology2000 2006;41:177-87. | 5. Six N, Tompkins K, LasFargues J-J, Veis A, Goldberg M. Bioengineering of reparative dentin and pulp mineralization. Quitessence Publishing 2001; Proceedings of International Conference on Dentin Pulp Complex: 52-9. | 6. Yamamoto H, Cho S-W, Kim E-J, Kim J-Y, Fujiwara N, Jung H-S. Developmental proprerties of the hertwig's epithelial root sheath in mice.J Dent Res 2004;83(9):688-92. | 7. Gronthos S ,Brahim J, Fisher LiLW, Chirman N, Boyde A, Denbesten P et al. Stem cell properties of human dental pulp stem cells. J Dent Res 2002;81(8)531-5.. | 8. Miura M ,Gronthos S, Zhao M, Lu B, Fisher LW, Robey PG et al. SHED: Stem cells from human exfoliated deciduous teeth .Proc Nat AcadSci USA 2003 May 13;100(10):5807-12 | 9. Lui H, Li W, Goa C, Kumagai V, Blacher MW, DenBesten PK. Dentonin., A fragment of MEPE, Enhanced Dental Pulp Stem Cell Proliferation. J Dent Res2004;83(6):496-9. | 10. Smith AJT. Tooth tissue engineering and Regeneration-a translational vision! J Dent Res2004;83(7):517. | 11. Modino SAC, Sharpe PT. Tissue engineering of teeth using adult stem cells. Archives of Oral Biology2005;50:255-8. | 12. Iohara K, Zheng Li, Ito M, Tomokiyo A, Matsushita K, Nakashima M. Side population cells isolated from porcine dental pulp tissue with self renewal and multipotency for dentinogenesis, chondrogenesis, adipogenesis, and neurogenesis.Stem cells2006;24:2493-503. | 13. DuailibiMT ,Dualibi SE, Young CS, Bartlett JD, Vaccanti JP, Yelick PC. Bioengineered teeth from cultered rat tooth bud cells. J Dent Res2004;83(7):523-30. | 14. Sonoyama W, Liu Y, Fang D, Yamaza T, Seo BM, Zhang C et al. Mesenchymal stem cell mediated functional tooth regeneration in swine. PloS One2006 Dec;1(1):1-8. | 15. Cheng PH, Snyder B, Fillos D, Ibegbu CC, Huang AH-C, Chan A WS. Postnatal stem/progenitor cells derived from the dental pulp of adult chimpanzee.Available from http://www.biomedcentral.com/1417-2121-9-20. | 16. Gronthoss, MankaniM, Brahim J, Robey GP ,Shi S. Post Natal Human Dental Pulp Stem Cells(DPSCs)in vitro and in vivo. Proc Nat AcadSci USA 2000 Dec 5;97(25):13625-30. | 17. Yelick PC, Vacanti JP. Bioengineered teeth from tooth bud cells. DCNA 2006 Apr;50:191-203. | 18. Honda MJ, Nakashima F, Satomura K, Shinohara Y, Tsuchiya S, Wantanabe N, Ueda M. Side population cells expressing ABCG-2 in Human adult dental pulp tissue.IntEndodJ 2007;40:949-58. |