Stem cells: Tomorrow's dentistry today

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Abstract:

For many centuries till now, scientists are trying their best to known how certain animals have ability to regenerate missing parts of their bodies. Humans actually share this ability with animals like the starfish and the newt (aquatic amphibian). Our bodies are constantly regenerating blood, skin, and other tissues. Human cells that have the potential to develop into other cell types within the body are stem cells and thereby repair injured cells. In the upcoming events of development in the field of dentistry, stem cells establish its significant role in Tooth/Root regeneration, Salivary gland regeneration, tongue regeneration, dentin-enamel regeneration, mandibular condyle regeneration, etc.

Most research is directed toward regeneration of damaged dentin, pulp, resorbed root, periodontal regeneration and repair perforations. Tooth regeneration to replace the traditional dental implants is also a new area of concern to many scientists. Dental stem cells, tissue-engineering applications can be used to promote more rapid healing of oral wounds and ulcers. Also, the use of gene-transfer methods to manipulate salivary proteins and oral microbial colonization patterns are promising and possible through stem cells. The term stem cell coined back in the 1908 when it was first proposed for scientific use by Russian histologist Alexander Maksimov in 1908 till 1999 when adult epithelial stem cell niche was first demonstrated via organ culture of the apical end of the mouse incisor.

All multi cellular organisms have stem cells present in them. They are distinguished by the ability to renew themselves through mitotic cell division and differentiate into a diverse range of specialized cell types. The two prime features of a stem cell are:

- Self-renewal, while maintaining the undifferentiated state, the cell has the ability to go through numerous cycles of cell division. One daughter cell remains a stem cell, while the other becomes committed to forming a particular cell type by a process called "asymmetric cell division". A single stem cell completely re-forms a particular tissue when it is transplanted within the body.

- Potency - the potential to differentiate into specialized cell types. In the strictest sense, this requires stem cells to be either totipotent or pluripotent – which will be able to give rise to any mature cell type, although multipotent or unipotent progenitor cells are seldom referred to as stem cells.

In the department of oral pathology, Oral submucous fibrosis is a common potentially malignant disorder which results in improper muscle function and Dry Mouth (lack of salivation) with burning sensation. After 4 weeks of stem cell injection, it was seen that there was gradually relief from burning sensation, increased salivary secretion and a 4mm increase in the mouth opening. H&E stain comparison of pre and post injection biopsy showed signs of angiogenesis with increase in number of capillaries, return of wavy pattern of collagen fibres with less inflammatory cell infiltration indicating the degranulation of the fibrous tissue and loosely organised connective tissue, all indicating a resumption towards a normal histology.

It is seen that dental stem cells have the potential to be utilized for medical applications like heart therapies, regenerating brain tissue, for muscular dystrophy therapies and for bone regeneration. Stem cells from human deciduous teeth can be used to develop cartilage as well as adipose tissue. In 2008, first advanced animal study for bone grafting was done resulting in reconstruction of large size cranial bone defects in rats with human dental pulp stem cells.

Globally, stem cell science continues to advance at an amazing rate. Though, countries differ in their regulatory approaches to this science, yet it remains an international endeavor to succeed in developing functional stem cells and their further application. Research teams are composed of scientists from around the globe, to assure the access to cell lines that have been created in other parts of the world. In September of 2018, the umbilical cord blood transplant and newborn stem cell banking communities celebrated the 30th anniversary of the first hematopoietic stem cell (HSC) transplant using cord blood as a graft for a patient with Fanconi's anemia. The successful demonstration that cord blood is capable of renewing a patient's blood and immune system, in combination with the confirmation that cord blood can be cryopreserved for later use. This led to the establishment of cord blood banks, and thus the newborn stem cell banking industry, in the early 1990s.

Stem Cell Research offers great potential for understanding basic mechanisms of human development and differentiation. Also provides a hope for new treatments for diseases such as diabetes, spinal cord injury, Parkinson's disease, and myocardial infarction. Pluripotent stem cells preserve themselves in culture media and can differentiate into all types of specialized cells. Scientists have plans to differentiate these pluripotent cells into specialized cells that can be used for transplantation.

It is likely that the stem cell advancement is the availability of regenerative dental kits, which will enable the dentists the ability to perform and deliver stem cell therapies locally as part of routine dental practice. A novel method that holds promising future is to create stem cells from harvested human dental stem cells. This approach also opens dental stem cells into an embryonic state, thus expanding their prospective to

differentiate into a much wider range of tissue types. Researchers have made progress in making specific dental tissues or tooth like structures in animal studies but future advances in dental stem cell research will be able to regenerate functional tooth in humans.

As human stem cell research is a newer area, many industries developing cell therapies face several types of risks, and due to some mismanagement the companies are thus pushing this venture into a highly speculative enterprise. Present clinical trials are being performed on recombinant human fibroblast growth factor-2, human platelet-derived growth factor, and tricalcium phosphate (GEM-21). Looking at the ongoing clinical trials, it is too early to assess whether the therapies based on stem cells will prove to be clinically effective or not.

The regeneration of tissues and organs and the use of Stem Cells for clinical uses are and will remain a challenge for the development of cell therapy and tissue engineering. Fetal and adult Stem Cells and in particular mesenchymal Stem Cells provide exciting therapeutic tools of regenerative medicine. However, some basic research should be done for better understanding the biological process and molecular mechanism of Stem Cell differentiation.

References:

1. Zhang SC, Conaghan J. Understanding stem cells, National academy of sciences (U.S). 2004; 101:1-26.

2. Torrisi CP. Embryonic vs. Adult. J of Health & Biomed law 2007;3:143-62.

3. Jain A, Bansal R. Regenerative medicine: Biological solutions to biological problems. Indian J Med Spec. 2013;4:41–6.

4. Vanishree N, Chaithra V, et al. A tooth for a tooth: dental stem cell banking in India. Arrals and Essences of Dentistry 2011;3:90-94.

5. . Narwal A, Gupta S, Hooda A.Dental stem cells – Sources and identification methods. CHRISMED J Health Res 2019;6:1-6.

6. Bone marrow stem cells in oral submucous fibrosis. (Internet).2013 www.miltenyibiotec.com,12740 earhart avenue auburn (USA).

7. Gandia C, Armiñan A, García-Verdugo JM, Lledó E, Ruiz A, Miñana MD, et al. Human dental pulp stem cells improve left ventricular function, induce angiogenesis, and reduce infarct size in rats with acute myocardial infarction. Stem Cells. 2008;26:638–45.

8. Nosrat IV, Widenfalk J, Olson L, Nosrat CA. Dental pulp cells produce neurotrophic factors, interact with trigeminal neurons in vitro, and rescue motoneurons after spinal cord injury. Dev Biol. 2001;238:120–32.

9. Kerkis I, Ambrosio CE, Kerkis A, Martins DS, Zucconi E, Fonseca SA, et al. Early transplantation of human immature dental pulp stem cells from baby teeth to golden retriever muscular dystrophy (GRMD) dogs: Local or systemic? J Transl Med. 2008;6:35.

10. Graziano A, d'Aquino R, Cusella-De Angelis MG, De Francesco F, Giordano A, Laino G, et al. Scaffold's surface geometry significantly affects human stem cell bone tissue engineering. J Cell Physiol. 2008;214:166–72.

11. Graziano A, d'Aquino R, Laino G, Papaccio G. Dental pulp stem cells: A promising tool for bone regeneration. Stem Cell Rev. 2008;4:21–6.