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

REVIEW ARTICLE

Stem Cells in Dentistry

Ashish Pandey[1], Vivek Singhai[2], Anmol Bagaria[3], Vibhor Azad[4], Gagandeep Kaur[5]

[1] Head of the Department of Prosthodontics, Daswani Dental College & Research Centre, Kota Rajasthan;
[2]Private practitioner, Bhopal, M.P.;
[3]BDS (Bharati Vidyapeeth Deemed to be University's Dental College & Hospital, Navi Mumbai) Private practitioner, Mumbai, Mahrashtra;
[4] B.D.Sv(Awadh Dental College Jamshedpur)vPrivate Practitioner, Jamshedpur;
[5]BDS final year, ITS Dental College, Murad nagar, Ghaziabad, U.P., India

***ABSTRACT*:**
The human body is made up of three basic categories of cells: germ cells, somatic cells and stem cells. The materials required for tissue engineering include stem cells, morphogens (or growth factors) and a scaffold to guide cell growth. The present review article highlighted the role of stem cells in dentistry.
Key words: Dentistry, Gingival, Stem cells

Received: 12 June, 2019 Revised: 27 June, 2019 Accepted: 28 June, 2019

Corresponding author: Dr. Anmol Bagaria, BDS (Bharati Vidyapeeth Deemed to be University's Dental College & Hospital, Navi Mumbai) Private practitioner, Mumbai, Maharashtra

This article may be cited as: Pandey A, Singhai V, Bagaria A, Azad V, Kaur G. Stem Cells in Dentistry. Int J Res Health Allied Sci 2019; 5(4):32-34.

INTRODUCTION

The human body is made up of three basic categories of cells: germ cells, somatic cells and stem cells. The materials required for tissue engineering include stem cells, morphogens (or growth factors) and a scaffold to guide cell growth. Scientific study into cell-based therapies has identified tremendous potential for the use of these stem cells to treat a number of diseases and disorders.[1]

It is now accepted that progenitor/stem cells reside within orofacial region. Stem cells residing in the orofacial region have been classed as the Mesenchymal stem cells (MSCs)/Adult stem cells (ASCs)/ Tissue stem cells (TSCs). Studies have identified several niches of multipotent mesenchymal progenitor cells, known as dental pulp stem cells, which have a high proliferative potential for self-renewal. These progenitor stem cells are now recognized as being vital to the dentine regeneration process following injury. More recently, researchers have discovered that stem cells harvested from deciduous teeth may be a source of tissue regeneration and repair. Five different types of dental stem cells isolated from dental soft tissues are dental pulp, apical papilla, dental follicle and periodontal ligament.[2]

In general, tissue engineering strategies in the field of dentistry using dental stem cells are mainly applied for whole tooth regeneration or development of wide variety of orodental structures including resorbed root, cervical, or apical dentin, periodontal structures and gingival, which can facilitate and restore the physiological structural integrity. In this regard, efforts to formulate bioengineered teeth were made by seeding dental epithelium and mesenchymal tissues or dissociating embryonic tooth germs to prefabricated tooth shaped scaffolds. Eventually, it led to the formation of basic tooth-like structures with the development of enamel, dentin, and pulp.[2]

STEM CELL TYPES

Stem cells can be broadly divided into

1. Embryonic stem cell
2. Adult stem cell
• Hematopoietic stem cell
• Mesenchymal stem cell
3. Induced pluripotent stem cell

SOURCES OF STEM CELLS[3]

The oral and maxillofacial region can be treated with stem cells from the following sources
1. Bone marrow
2. Adipose tissue
3. Stem cells from oral and maxillofacial region

Bone marrow

Bone marrow stem cells (BMSCs) can be harvested from sternum or iliac crest. It is composed of both hematopoietic stem cells and mesenchymal stem cells (MSCs). The majority of oro-maxillofacial oral structures are formed from mesenchymal cells. The advantage of bone marrow is that it has a larger volume of stem cells and can be differentiated in to wide variety of cells. Isolation of BMSCs can be carried out only under general anesthesia with possible post operative pain.

Adipose tissue

They can be harvested from the lipectomy or liposuction aspirate. Adipose derived stem cells (ADSCs) contain a group of pluripotent mesenchymal stem cells that exhibit multilineage differentiation. Advantage of adipose tissue is that it is easily accessible and abundant in many individuals.[4]

Dental Pulp Stem Cells (DPSC)

Their source is dental pulp mesenchyme (neural crest mesenchyme). They are slow cycling cells having restricted potential and represent mature adult pulp stem cells. They have better immunologic/host acceptance. In vitro they formed odontoblasts, osteoblasts, endothelial cells, adipocytes, chondrocytes, neurons and smooth muscle cells while in vivo, various directions like odontogenic, myogenic, adipogenic, angiogenic and osteogenic are found and were able to form complete dentin pulp complex. Its in vitro developmental capability and in vivo therapeutic targeting is yet to be explored.

Stem Cells From Human Exfoliated Deciduous Teeth (SHED):

Their source is human exfoliated deciduous teeth (coronal pulp). They are multipotent cells with very high proliferative potential and higher cell doublings. In vitro they can differentiate odontogenically, osteogenically, adipogenically, chondrogenically, or neurally. In vivo they can form neurons, adipocytes, odontoblasts, and osteoinductive and endothelioid cells. But they failed to form complete dentin pulp complex in vivo.[5]

Oral Epithelial Stem Cells (OESCs)

They are derived from oral epithelial progenitor cells from basal layer of oral mucosa. They are unipotent stem cells and possess clonogenicity. They can form highly stratified and well organized graft. But they cannot differentiate into mesenchymal cell lineage.

Gingiva derived MSCs (GMSCs)

These cells are derived from lamina propria of gingiva. They possess clonogenicity, self-renewal and multipotent differentiation capacity similar to BMSCs and proliferate faster than BMSCs, displaystable morphology after extended passages. These cells exhibit adipogenic, osteogenic and chondrogenic potential along with immuno-modulatory effect on lymphocytes. Their applications further need to be explored.[6]

Salivary gland stem cells (SGSCs)

They are derived from the stromal tissue of salivary glands. They are useful for regeneration of salivary gland damaged from irradiation and can be guided to osteogenic, chondrogenic and adipogenic differentiation. It is difficult to isolate salivary gland stem cells from the collection of stromal cells.[7]

Tooth Germ Progenitor Cells (TGPCs)

They are the stem cells in the mesenchyme of the third molar tooth germ and possess very high proliferative activity. They can differentiate into lineages of three germ layers including osteoblasts, neural cells and hepatocytes. Their applications further need to be explored.[8]

Stem cells from the oral and maxillofacial region

Stem cells from oral and maxillofacial region predominantly contain mesenchymal stem cells. In oral and maxillofacial area different types of dental stem cells were isolated and characterized. They include
• Dental pulp stem cells (DPSCs).
• Stem cells from exfoliated deciduous teeth (SHED).
• Periodontal ligament stem cells (PDLSCs).
• Stem cells from apical papilla (SCAP).
• Dental follicle progenitor cells (DFPCs).[9]

Dental stem cell advantages

The advantages of stem cells from oral and maxillofacial region is that
1. Have high plasticity.
2. It can be cryopreserved for longer period (Ideal for stem cell banking).
3. It showed good interaction with scaffold and growth factors.
4. Stem cells transplantations can cause pathogen transmission and also need immunosuppression, so autologous stem cell source is the best option. Dental pulp stem cells will be better fitting tool due to easy surgical

access, the very low morbidity of the anatomical site after the collection of the pulp.[10]

Stem cells in periodontal regeneration

Stem cells will be a promising tool for regenerating the periodontal structures such as periodontal ligament and other supporting elements. BMSCs have the ability to produce alveolar bone, periodontal ligament, and in vivo cementum after implantation into the periodontal defects. [11]Thus, it was proved BMSCs provides an alternative source for the treatment of periodontal diseases. Autologous mesenchymal stem cells from iliac crest in combination with platelet rich plasma from peripheral blood was used for periodontal regeneration. Significant closure of bone defect and improvement of attachment level was observed after one year follow up. It also showed good healing and regeneration of interdental papilla.[12]

Regeneration of craniofacial defects

Stem cells can be useful in the regeneration of bone and to correct large craniofacial defects due to cyst enucleation, tumor resection, and trauma. The closure of a bone defect is commonly carried out with the transfer of tissue, which have disadvantages like, not able to restore the unique function of the lost part, donor site morbidity, accompanied by scarring, infection and loss of function.[13]

Tooth regeneration

The regeneration of adult teeth will be possible in future with the newer advancement in stem cell therapy and tissue engineering. Regenerative procedures would be better fitting and alternative tool in place of dental implants. Experimental studies with animal models have shown that the tooth crown structure can be regenerated using tissue engineering techniques that combine stem cells and biodegradable scaffolds.[14]

Conclusion

Future tissues like tissue engineered bone grafts, engineered joints and cranial sutures can be developed with stem cell therapy. A team of professionals including stem cell biologists, molecular biologists, geneticists, polymer and materials scientists, mechanical engineers and clinicians with knowledge of oral and maxillofacial disorders is needed to develop the field of craniofacial tissue engineering.

References

1. Thomson JA, Itskovitz-Eldor J, Shapiro SS, Waknitz MA, Swiergiel JJ, Marshall VS. Embryonic stem cell lines derived from human blastocysts. Science 1998; 282:1145-7.
2. Keller GM. In vitro differentiation of embryonic stem cells. Curr Opin Cell Biol 1995; 7: 862-9.
3. Wu DC, Boyd AS, Wood KJ. Embryonic stem cell transplantation: Potential applicability in cell replacement therapy and regenerative medicine. Front Biosci 2007; 12:4525-35.
4. Takahashi K, Yamanaka S. Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by denied factors. Cell 2006; 126:663-76.
5. Zuk PA, Zhu M, Mizuno H, Huang J, Futrell JW, Katz AJ, et al. Multilineage cells from human adipose tissue: Implications for cell- based therapies. Tissue Eng 2001;7: 211-28.
6. Gronthos S, Mankani M, Brahim J, Robey PG, Shi S. Postnatal human dental pulp stem cells (DPSCs) in vitro and in vivo. Proc Natl Acad Sci U S A 2000; 97:13625-30.
7. Miura M, Gronthos S, Zhao M, Lu B, Fisher LW, Robey PG, et al. SHED: Stem cells from human exfoliated deciduous teeth. Proc Natl Acad Sci U S A 2003; 100:5807-12.
8. Seo BM, Miura M, Gronthos S, Bartold PM, Batouli S, Brahim J, et al. Investigation of multipotent postnatal stem cells from human periodontal ligament. Lancet 2004; 364:149-55.
9. Sonoyama W, Liu Y, Yamaza T, Tuan RS, Wang S, Shi S, et al. Characterization of the apical papilla and its residing stem cells from human immature permanent teeth: A pilot study. J Endod 2008; 34:166-71.
10. Morsczeck C, Götz W, Schierholz J, Zeilhofer F, Kühn U, Möhl C, et al. Isolation of precursor cells (PCs) from human dental follicle of wisdom teeth. Matrix Biol 2005; 24:155-65.
11. Huang GT, Gronthos S, Shi S. Mesenchymal stem cells derived from dental tissues vs. those from other sources: Their biology and role in regenerative medicine. J Dent Res 2009; 88:792-806.
12. D'aquino R, De Rosa, A, Laino G, Caruso F, Guida L, Rullo R, Checchi V, Laino L, Tirino V, Papaccio G. Human dental pulp stem cells from biology to clinical applications. J Exp Zool 2008;312:408–15.
13. Miura M, Gronthos S, Zhao M, Lu B, Fisher LW, Robey PG, Shi S . SHED: stem cells from human exfoliated deciduous teeth. Proc Natl Acad Sci USA 2003;100:5807-5812.
14. Bluteau G, Luder HU, Bari CD, Mitsiadis TA. Stem cells for tooth engineering. Eur cell Mater 2008;16:1-9.