ISSN: 0976-3031

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

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 8, pp. 19228-19230, August, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Review Article

DENTAL TISSUE ENGENEERING: A REVIEW

Pradnya V. Bansode., Seema D. Pathak., Wavdhane M. B., Shirish Khedgikar and Shilpa H. Rai

Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra. India

DOI: http://dx.doi.org/10.24327/ijrsr.2017.0808.0652

ARTICLE INFO

Article History:

Received 15th May, 2017
Received in revised form 25th June, 2017
Accepted 23rd July, 2017
Published online 28th August, 2017

Key Words:

Applications, dental tissue, preservation, regeneration, stem cells.

ABSTRACT

Dental tissues are easy to get, less traumatic but abundant of mesenchymal stem cell, so it becomes an important source of mesenchymal stem cells and has great significance for stem cell treatment and dental tissue engineering. The objective of this review article is to discuss the history of stem cells, different stem cells relevant for dentistry, preservation of dental stem cells along with the current status of dental and medical applications.

INTRODUCTION

There has been a clear and distinct hypothetical shift in regenerative medicine from using medical devices and whole tissue grafts, to a more explicit approach that utilizes specific bioactive, biodegradable synthetic or natural scaffolds combined with cells and/or biological molecules, to create a functional replacement tissue in a diseased or damaged site (1). Dental tissues are easy to get, less traumatic but abundant of mesenchymal stem cell, so it becomes an important source of mesenchymal stem cells and has great significance for stem cell treatment and dental tissue engineering.(2) (3) (4). Dental pulp mesenchymal stem cells (DPMSCs) highly express mesenchymal stem cell markers and possess the potential to differentiate into neural cells, osteoblasts, adipocytes, and chondrocytes. (5)

The objective of this review article is to discuss the history of stem cells, different stem cells relevant for dentistry, preservation of dental stem cells along with the current status of dental and medical applications.

Historical Background

In 1868, the term "stem cell" for the first time appeared in the works of German biologist Haeckel. (6) Wilson coined the term stem cell. (7) In 1908, Russian histologist, Alexander Maksimov, postulated existence of hematopoietic stem cells at congress of hematologic society in Berlin. The discovery of stem cells in the pulp of permanent teeth and also in deciduous teeth raised the intriguing possibility of using dental pulp stem cells for tissue engineering. Feldman in the year of 1932 stated evidence of regeneration of dental pulp under certain optimal biological conditions. Milestone in dental history was when Gronthos *et al*. identified and isolated odontogenic progenitor population in adult dental pulp achieved in year 2000 (9).

Types of Stem Cells- (10)

Based on the origin from which they are obtained, stem cells are classified as

Embryonic stem cells

These are also known as postnatal stem cells. They are derived from cells of the inner cell mass of the blastocysts, during embryonic development.

Adult stem cells

Adult stem cells are also known as somatic stem cells.

1. Bone marrow derived stem cells
2. Adipose-derived adult stem cells
3. Umbilical cord stem cells
4. Amniotic fluid–derived stem cells
5. Induced pluripotent stem cells

Corresponding author:* **Pradnya V. Bansode
Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra. India

6. Dental stem cells: These are the most accessible stem cells (11). Two major cell types are involved in dental hard tissue formation (12). Epithelium - derived ameloblasts that form enamel and the mesenchymal - originated odontoblasts that are responsible for the production of dentin. Following are the different dental stem cells-

Dental pulp stem cells

DPSCs are mesenchymal type of stem cells inside dental pulp (13). DPSCs have osteogenic and chondrogenic potential in vitro and can differentiate into dentin, in vivo and also differentiate into dentin-pulp-like complex (9).

Some studies have proven that DPSCs are capable of producing dental tissues in vivo including dentin, pulp and crown like structures, where as other investigations suggested that these stem cells can bring about formation of bonelike structures. Theoretically, a bio-tooth made from autogenous PSCs should be the best choice for clinical tooth reconstruction. (13).

Stem cells from human exfoliated deciduous teeth (SHED)

Dr. Songtao Shi discovered SHED in 2003. The volume of pulp tissue remaining in exfoliated deciduous teeth is extremely small, and sometimes it is difficult to isolate and expand them. (14).These cells are able to grow into specialized cell types by a process called 'differentiation'. These cells could differentiate into adipocytes, chondontocytes, osteoblasts, and neurons in vitro. The main task of these cells seems to be the formation of mineralized tissue, which can be used to enhance orofacial bone regeneration.

Periodontal ligament stem cells

Seo *et al*. first described the presence of multipotent postnatal stem cells in the human periodontal ligament (15). These cells can also be isolated from cryopreserved periodontal ligaments while retaining their stem cell characteristics, including single-colony strain generation, cementum/periodontal ligament- like tissue regeneration, expression of MSC surface markers, multipotential differentiation and hence providing a ready source of MSCs. (16).

Stem cells from the apical part of the papilla

Sonoyama *et al* in 2006 isolated a new population of dental stem cells, and called them stem cells from the apical part of the papilla (SCAPs) (17). . Similar to other dental stem cells, SCAPs express the early mesenchymal surface markers, STRO-1 and CD146.(18).

Stem cells from the dental follicle

In 2005, Morsczeck *et al* isolated Stem Cells from the dental follicle of human third molars, which expressed the stem cell markers Notch1, STRO-1, and nestin.(19).

Stem Cells Storage

Stem cell storage can be stored as-

1. Cryopreservation
2. Magnetic freezing.

Tooth Stem Cell Banking

The first commercial tooth bank was established in 2004 at National Hiroshima University, Japan (20, 21). The company was named as "Three Brackets" (Suri Buraketto). Companies like Store-A- Tooth (Provia Laboratories, Littleton, Massachusetts, USA) and StemSave (Stemsave Inc, New York, USA), BioEden (Austin, Texas, USA) are now expanding their horizon globally in favor of tooth stem cells banking.

Stemade introduced the concept of dental stem cells banking in India recently by launching its operations in Mumbai and Delhi. (22).

Applications of Stem Cells in Dentistry

Cell injection therapy

Since the tissue formation resulted from cellular action, injection of inherently intelligent cells, stem cells in particular, into the defect have been suggested to regenerate tissues. However, immunological rejection and the ability of the injected cells to maintain their phenotype are other challenges.

Cell induction therapy

Due to the limitations with cell injection therapy, there has been a clear and distinct shift to recruiting the circulating body cells to regenerate the tissues.

Cells seeded scaffolds

This strategy depends on the isolation of appropriate cell population from a biopsy taken from the patient or a donor. These are now being recognized as an essential cell type that possesses important immunomodulatory properties capable of treating a variety of immune-related diseases.

Regeneration of the dentine-pulp complex

Concept of root canal revascularization via blood clotting

Revascularization of the necrotic root canal systems by disinfection followed by establishing bleeding into the canal system via overinstrumentation has shown successful results for revascularization of root canals (23, 24).

Postnatal stem cell therapy

Postnatal stem cells derived from skin, buccal mucosa, fat, and bone is being injected into disinfected root canal systems after the apex is opened.

Pulp implantation

The pulp cells can be grown on biodegradable membrane filters to transform two-dimensional into three-dimensional cell cultures.

Three-dimensional cell printing-

The three-dimensional cell printing technique can be used to precisely position cells so that they have the potential to create tissue constructs that mimic the natural tooth pulp tissue structure.

Gene therapy

Huang, *et al*. explored in mice that pulp-like tissue can be regenerated de novo in an emptied root canal space by stem cells from apical papilla and dental pulp that give rise to

odontoblast-like cells, producing dentin-like tissue on the existing dentinal walls via stem/progenitor cell-based approaches and tissue engineering technologies.

CONCLUSION

The future of these therapies involving more biological approaches and the use of dental tissue stem cells is promising and advancing. Also there may be a significant interest of their application and wider potential to treat disorders beyond the craniofacial region.

References

1. Fujimura, K. Bessho, Comparison of human mesenchymal stem cells derived from bone marrow, synovial fluid, adult dental pulp, and exfoliated deciduous tooth pulp, *International journal of oral and maxillofacial surgery*, 45 (2016) 124-131.
2. H. Egusa, W. Sonoyama, M. Nishimura, I. Atsuta, K. Akiyama, Stem cells In dentistry--pt I: stem cell sources, *Journal of prosthodontic research*, 56 (2012)151-165.
3. H. Egusa, W. Sonoyama, M. Nishimura, I. Atsuta, K. Akiyama, Stem cells in dentistry--Part II: Clinical applications, *Journal of prosthodontic research*, 56 (2012)229-248.
4. A.J. Friedenstein, R.K. Chailakhjan, K.S. Lalykina, The development of fibroblast colonies in monolayer cultures of guinea-pig bone marrow and spleen cells, *Cell and tissue kinetics*, 3 (1970) 393-403.
5. K. Handa, M. Saito, A. Tsunoda, M. Yamauchi, S. Hattori, S. Sato, M. Toyoda, T.
6. Teranaka, A.S. Narayanan, Progenitor cells from dental follicle are able to form cementum matrix in vivo, Connective tissue research, 43 (2002) 406-408.
7. Wilson EB. The Cell in Development and Inheritance. 1st ed. New York: Macmillan Company; 1996.
8. Maximow A. The lymphocyte as a stem cell, common to different blood elements in embryonic development and during the post-fetal life of mammals. *Folia Haematol* 1909; 8:123-34.
9. 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.
10. Girish Chaudhary, Nimisha Chaudhary, Anshul Chaudhary, Biotooth-A Dream or Reality. *Annals of Prosthodontics and Restorative Dentistry,* October-December, 2015;1(1):16-19.
11. Mao JJ, Collins FM. Stem Cells: Sources, therapies and the dental professional. [Last cited on 2011 May 10]. Available from: http://www.ineedce.com/ courses/1486/PDF/StemCells.pdf .
12. Yamamura T. Diff erentiation of pulpal cells and inductive influences of various matrices with reference to pulpal wound healing. *J Dent Res* 1985; 64 Spec No: 530-40.
13. Murray PE, Garcia-Gadoy F, Hargreaves KM. Regenerative endodontics: A Review of current status and a call for action. *J Endod* 2007; 33:377-390.
14. Nobuyuki Kawashima, Sonoko Noda, Mioko Yamamoto, and Takashi Okiji, DDS, PhD
15. 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.
16. Seo BM, Miura M, Sonoyama W, Coppe C, Stanyon R, Shi S. Recovery of stem cells from cryopreserved periodontal ligament. *J Dent Res* 2005; 84:907-12.
17. Sonoyama W, Liu Y, Fang D, Yamaza T, Seo BM, Zhang C, *et al*. Mesenchymal stem cell-mediated functional tooth regeneration in swine. PLoS One. 2006; 1:e79.[PMCID: PMC1762318] [PubMed: 17183711].
18. Jamal M, Chogle S, Goodis H, Karam SM. Dental stem cells and their potential role in regenerative medicine. *J Med Sci.* 2011; 4:53-61.
19. Morsczeck C, Gotz W, Schierholz J, Zeilhofer F, Kuhn U, Mohl C, *et al*. Isolation of precursor cells (PCs) from human dental follicle of wisdom teeth. Matrix Biol. 2005;24:155–65Yen- Hue Huang, Jen-Chang Yang *et al*. al. Dental stem cells and tooth banking for regenerative medicine. *J Exp Cli Med* 2010; 2:111-117.
20. Coburn RJ, Henriques BL, Francis LE. The development of an experimental tooth bank using deep freeze and culture techniques. *J Oral Ther Pharmacol* 1966; 2:445-50.
21. Ramta Bansal, Aditya Jain, Current overview on dental stem cells applications in regenerative dentistry, *Journal of Natural Science, Biology and Medicin*e | January 2015 | Vol 6 | Issue 1.
22. Reynolds K, Johnson JD, Cohenca N. Pulp revascularization of necrotic bilateral bicuspids using a modified novel technique to eliminate potential coronal discolouration: A case report. *Int Endod J.* 2009; 42:84-92.
23. 66. Shin SY, Albert JS, Mortman RE. One step pulp revascularization treatment of an immature permanent tooth with chronic apical abscess: A case report. *Int Endod J.* 2009; 42:1118-26.
24. Kindler V. Postnatal stem cell survival: Does the niche, a rare harbor where to resist the ebb tide of differentiation, also provide lineage-specific instructions? *J Leukoc Biol*. 2005;78:836-44.
25. Huang GT, Yamaza T, Shea LD, Djouad F, Kuhn NZ, Tuan RS, *et al*. Stem/progenitor cell-mediated de novo regeneration of dental pulp with newly deposited continuous layer of dentin in an in vivo model. Tissue Eng Part A. 2010; 16:605-15. [PMCID: PMC2813150]

How to cite this article:

Pradnya V. Bansode *et al*.2017, Dental Tissue Engeneering: A Review. *Int J Recent Sci Res.* 8(8), pp. 19228-19230. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0808.0652

****