Dental Stem Cells: The Future of Research and Practice

Saini R*, Giri PA**, Saini SR***

Sir,

Stem cells are immature, unspecialized cells in the body that are able to grow into specialized cell types by a process known as "differentiation." There are two primary sources of stem cells: embryonic stem cells and adult stem cells, the latter of which are found in many organs and tissues in the human body, including the dental pulp contained within teeth. Embryonic stem cells have the ability to grow into any cell type in the body. However, there is great ethical controversy regarding obtaining and using these stem cells for medical research and treatment purposes. Teeth are the most natural, non-invasive source of stem cells. Dental stem cells are easy, convenient and affordable to collect. The dental stem cells hold the promise for a range of very interesting potential uses in the future. Regenerative capacity of the pulp has been known since long. Dental stem cell is not a new mention either. Stem cells also known as "progenitor or precursor" cells are defined as clonogenic cells capable of both self-renewal and multi-lineage differentiation.[1]

Stem cells have secured their place in medical field through their manifold applications. Whole new branch of regenerative medicine now exist benefiting medical field in its best possible way. Regenerative medicine is the process of replacing or regenerating human cells, tissues or organs to establish normal function.[2]

The concept of regeneration in dental field is recently introduced on basis of his experiments and clinical data that if certain biological conditions are created, regeneration of pulp might be achieved. Human dental stem cells that have been isolated and characterized are:

1. Dental pulp stem cells (DPSCS) [3]
2. Stem cells from exfoliated deciduous teeth (SHED) [4]
3. Stem cells from apical papilla (SCAP) [5,6]
4. Periodontal ligament stem cells (PDLSCS) [7]

Most research is directed toward regeneration of damaged dentin, pulp, resorbed root, periodontal regeneration and repair perforations. Whole tooth regeneration to replace the traditional dental implants is also in pipeline. Tissue-engineering applications using dental stem cells that may promote more rapid healing of oral wounds and ulcers as well as the use of gene transfer methods to manipulate salivary proteins and oral microbial colonisation patterns are possible.[8] Adult mesenchymal stem cells have been recently identified in the gingival connective tissues, namely gingival mesenchymal stem cells (GMSCs). They have osteogenic potential and are capable of bone regeneration in mandibular defects. GMSCs also suppress the inflammatory response by inhibiting lymphocyte proliferation and inflammatory cytokines and by promoting the recruitment of regulatory T-cells and anti-inflammatory cytokines.

Tooth-derived stem cells are readily accessible and provide an easy and minimally invasive way to obtain and store stem cells for future use. Banking one's own tooth-derived stem cells is a reasonable and simple alternative to harvesting stem cells from other tissues. Obtaining stem cells from baby teeth is simple and convenient, with little or no trauma. Furthermore, using one's own stem cells poses few, if any, risks for developing immune reactions or rejection following transplantation and also eliminates the potential of contracting disease from donor cells. Stem cells can also be recovered from developing wisdom teeth and permanent teeth. Individuals have different opportunities at different stages of their life to bank these valuable stem cells.

Dental stem cells have the potential to be utilized for

*Associate Professor, Dept. of Periodontology, RDC, Loni
** Professor, Dept. of Community Medicine (PSM) ,
Rural Medical College, Loni, Maharashtra, India
***Lecturer, Dept. of Prosthodontics, Rural Dental College, Loni, Maharashtra, India

Corresponding author:
Dr. Rajiv Saini
Dept. of Periodontology,
Rural Dental College, Loni, Maharashtra, India
Email:- drperiodontist@yahoo.co.in

medical applications like heart therapies [9], regenerating brain tissue [10], for muscular dystrophy therapies [11] and for bone regeneration [12,13]. SHED can be used to generate cartilage [14] as well as adipose tissue [15]. In 2008 1st advanced animal study for bone grafting was announced resulting in reconstruction of large size cranial bone defects in rats with human dental pulp stem cells.[16]

No doubt stem cells of dental origin have got multiple applications; there are certain limitations as well. The oncogenic potential of these cells is still to be determined in long term clinical studies. Moreover, the research is mainly confined to animal models; their clinical application on humans is yet to be tested. Another main issue to consider is the difficulty to identify, isolate, purify and grow these cells in lab. Immune rejection is also one of the issues which require a thorough consideration. Lastly, these are comparatively less potent than embryonic stem cells. Much progress has been made but still there is much work to be done in this regard. Teeth-like structures cannot replace actual teeth. Researchers still need to grow blood and nerve supply of teeth to make them functional. Although not currently available, these approaches may one day be used as biological alternatives to the synthetic materials currently used.

Certainly, current moves towards isolation, gathering, and cryopreservation of dental pulp progenitor cells for banking and clinical are now viable and commercially possible. Though, we have to approach the face up with careful consideration. We are still some distance from fully accepting the potential and behaviour of dental pulp progenitor cells, and successive clinical treatment modalities. However, the opportunities for their utilization in dental tissue regeneration are becoming clearer and will escort to considerable benefits in the management of the effects of dental disease.[17]

References

1. Fischbach G.D., Fischbach R.L. Stem cells: science, policy, and ethics. J Clin Invest 2004;11(10):1364-70.
2. Mason C, Dunnill P. A brief definition of regenerative medicine. Regen Med 2008;3(1):1–5.
3. 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 USA 2000;97(25):13625-30.
4. Miura M, Gronthos S, Zhao M, Lu B, Fisher L.W, Robey P. G. et al. SHED: Stem cells from human exfoliated deciduous teeth. Proc Natl Acad Sci USA 2003;100(10):5807–5812.
5. Sonoyama W, Liu Y, Fang D, Yamaza T, Seo BM, Zhang C et al. Mesenchymal stem cellmediated functional tooth regeneration in Swine. PLoS 2006;1(1):e79.
6. 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.
7. 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.
8. Jain A, Bansal R. Regenerative medicine: biological solutions to biological problems. Indian J Med Spec. 2013;4(1):41-46.
9. Gandia C, Arminan A, Garcia-Verdugo J.M, Lledo E, Ruiz A, Minana M.D 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 (3):638-45.
10. Nosrat I, 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(1): 120-32.
11. Kerkis I, Ambrosio C.E, Kerkis A, Martins D.S, Zucconi E, Fonseca AS 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.
12. Graziano A, D'aquino R, Angelis M, De F.F, Giordano A, Laino G et al. Scaffold's surface geometry significantly affects human stem cell bone tissue engineering". J Cell Physiol 2008;214(1):166-72.
13. D'aquino R, Papaccio G, Laino G, Graziano A. Dental Pulp Stem Cells: A Promising Tool for Bone Regeneration. Stem Cell Rev 2008;4(1):21–6.
14. Fecek C, Yao D, Kacorri A, Vasquez A, Iqbal S, Sheikh H et al. Chondrogenic derivatives of embryonic stem cells seeded into 3D polycaprolactone scaffolds generated cartilage tissue in vivo. Tissue Eng Part A. 2008; 14(8):1403-13.

15. D'Andrea F, De Francesco F, Ferraro GA, Desiderio V, Tirino V, De Rosa A et al. Large-scale production of human adipose tissue from stem cells: a new tool for regenerative medicine and tissue banking. Tissue Eng Part C Methods 2008;14(3):233-42.
16. De Mendonca Costa A, Bueno DF, Martins MT, Kerkis I, Kerkis A, Fanganiello RD et al. Reconstruction of large cranial defects in nonimmunosuppressed experimental design with human dental pulp stem cells. J Craniofac Surg 2008; 19(1):204-10.
17. Singh H, Bhaskar DJ, Rehman R, Jain CD, Khan M. Stem Cells: An Emerging Future in Dentistry. Int J Adv Health Sci 2014;1(2):17-23