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Mini Review

Dental Pulp Stem Cells and Their Importance in Regenerative Medicine

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Case 1

Stem cells are the "basis" of the construction of the whole human organism. From them all tissues are formed, all organs - they are the source of life. They have the fascinating potential to divide and create new cell types in the body. In addition to being built, they serve throughout life for the regeneration of the organism (Figure 1).

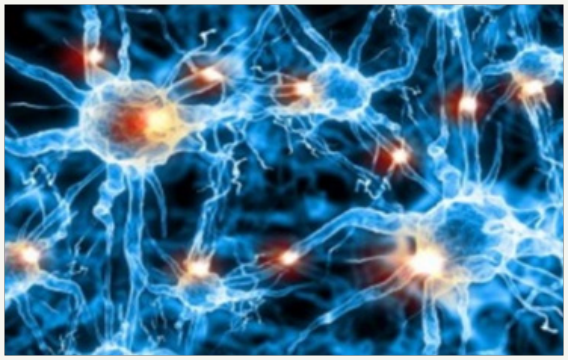

Figure 1:

What is their Secret?

Stem cells can be unlimitedly divided and specialized in any type of cell in our body. They are special because they know exactly how to find the diseased tissue in the body and regenerate it.

Stem cells have three key features

They are the foundation of the body: Stem cells are the foundation of a human organism. All organs and all tissues were created from them.

They recover damaged: The main role of stem cells is to create and restore tissue but also regenerate cells damaged by diseases and injuries from blood to kidney and muscle.

They have the power of transformation: Unlike specialized cells that have a specific role stem cells are of a universal type and have the fascinating possibility of transformation into almost all cells of a different type: heart, nerve, blood cells, kidneys, retina, etc [1].

Stem cell division

The stem cells are divided into:

i. Embryonic

ii. Stem cells from umbilical cord blood

iii. Adult stem cells

Embryonic stem cells: Found in the embryo and used mainly for research purposes in order to better understand the problems in the stem cell field.

Stem cells from the umbilical cord blood: Are found in the umbilical cord blood and completely safe and harmless to the mother and the newborn can be separated. These are young stem cells that were not influenced by external influences [2].

Adult stem cells: Their greatest concentration is in the spinal cord, and also in other organs. They are used extensively for the needs of treatment, but they have a drawback that they carry "traces of the previous life" -the former diseases, vaccinations, the influence of the external environment which makes them less vital.

Where are the Stem Cells located in the Body?

Stem cells can still be found in organs and tissues such as oral cavity (13 sites), liver, intestines, bone marrow, blood, muscles, skin, brain, fat tissue, etc.

What are the Stem Cell Treatment Options?

Today, most stem cell therapy is performed by the use of adult stem cells, but also stem cell therapy from umbilical cord blood has also provided remarkable results and is increasingly being used. For now, stem cells are used to treat diseases of the blood, metabolic and diseases of the immune system. Treatment with stem cells involves the regeneration of damaged tissues and organs. Own stem cells have already been successfully used in the treatment of cardio-vascular diseases [1].

How Does Medicine Develop in the Field of Stem Cells Application?

Stem cells have been used in medicine for the treatment of various diseases in the last few decades, as well as for various other treatments. Regenerative medicine is a relatively new area that is rapidly progressing as research is spreading to the whole world.

The first treatment for umbilical cord stem cells was: treatment of type 1 diabetes in children and adolescents as well as childhood paralysis resulting from brain damage due to lack of oxygen.

The subject of very intense research in recent years is the following areas:

A. Congenital heart defects (progressing with the development of heart valves)

B. Neurological disorders (such as spinal cord injury, brain injury, Parkinson's disease and stroke)

C. Transplantation of the skin, bones and cartilage

Significant success in treating with the cord blood stem cells was in 2009, when scientists from the Medical University of Hannover and the University of Barcelona presented four genes in umbilical cord blood stem cells called induced pluripotent stem cells (iPS cells). Their significance is that they can develop into all types of cells in the body and therefore hope for future therapies.

In support of the use of stem cells in medicine is fact that the 2012. Nobel Prize winners from the medical domain were Japan's scientist Shinya Yamanaka and Brittan's John B. Gurdon, scientists working on the use of stem cells in therapies.

What is the Potential for Stem Cells use in Medicine?

This field in medicine tells scientists to investigate the possibility of therapy for the treatment of cell-based diseases. With stem cells this is a great potential because scientists come to the knowledge of how the body develops an individual cell and how the healthy cell replace the diseased one in the body.

Stem cells can be programmed for various tasks in the future, actually, they can specialize and become heart, liver, blood cells. Cancellation or poor function of organs and tissues in the body can be regenerated. This is especially noticeable in degenerative diseases where new therapies are in sight.

What is the Significance of the Dental Pulp Stem Cells?

There are three populations of stem cells isolated from dental pulp up to date and classified as Dental Pulp Stem Cells (DPSC), Stem Cells From Human Exfoliated Decidual Teeth (SHED) [3,4] and Immature Stem Cells (IDPC) [5]. All stem cells of dental pulp are ectomeshenhimal germ origin and are localized in the perivascular niche. They are easily and effectively isolated, highly proliferative, clonogene, multipotent, exhibiting a high degree of plasticity and similar to meshenhimal bone marrow stem cells (BMSC) [5,6]. They showed high expression of alkaline phosphatase gene, dentine matrix protein 1 and dentin-sialophosphoprotein as well. It is also emphasized of the importance of expression of multiple genes that encode the synthesis of extracellular matrix components, cell adhesion molecule, growth factor, transcription factors, cellular cell transmission gene, cellular communication and metabolism. In vitro or in vivo conditions, these cells can be differentiated with certain differences between them in the direction of odontoblasts, chondrocytes, osteoblasts, adipocytes, neurons/glia, smooth and skeletal muscle cells, endothelial cells, and melanocytes. In vivo conditions, after implantation they show a different potential for the formation of dentine but also bone, adipose and nerve tissue [7,8].

It is generally believed that DPSC has anti-inflammatory effect and exhibit an immuno-modulating effect. They also lead to immunological tolerance if implanted into allogeneic tissues. The ability to inhibit the proliferation of T lymphocytes indicates their immuno-suppressive effect [9-11].

The dental pulp stem cells have opened up new perspectives in the therapeutic use of these cells not only in the regeneration of dentine, tissue of periodontium and bone-joint tissue of the cranio facial region but also in the treatment of neuro-trauma, autoimmune diseases, myocardial infarction, muscular dystrophy, and connective tissue damage [12-15].

The challenging and the promotion of osteogenesis in order to compensate physiologically and pathologically lost bone tissue is a major challenge in modern medicine and dentistry [16]. Although bone tissue has the ability to repair and regenerate bone loss after periapical infections, periodontal illness or trauma can lead to tooth loss if adequate treatment has not been applied [14,15]. In order to avoid auto-transplantation of bones from the distant parts of the body (crista iliaca, ribs), modern dentistry is increasingly resorting to the application of various alloplastic materials, allografts and xenografts [9,17].

However, all of these materials have their application limits and disadvantages. Allogeneic and xenogeneic grafts have similar biochemical characteristics as bone (biomechanical stability and elasticity) but a major disadvantage is the inability to initiate osteogenesis. Progress in stem cell research would help solve some of these problems [18]. Dental pulp stem cells - DPSCs have the ability to differentiate into different phenotypes such as osteoblasts, myoblasts, chondrocytes and adipocytes. In according with multipotency of these cells the researchers hope for their wide application in regenerative endodontics especially in the treatment of the root canal with incomplete root growth.

The concept of stem cells application in endodontics is based on a concept that includes three basic components: a source of cells, a carrier (of natural origin or synthetic polymers) and the application of signal molecules (TGF / BMPs) [19]. An adequate source of cells would be one that allows differentiation in the desired cell type and in addition it is generous and easily accessible and

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reciprocally autogenous, thereby avoiding the immune response. Recent researches have proven the possible creation of a tissue very similar to the physiological tissue of tooth pulp from stem cells exfoliated from decidual teeth. During the tissue engineering of pulp and periodontal tissue from stem cells of dental pulp and stem cells of periodontal ligament polymers and bovine collagen carriers were shown as the most acceptable carriers [18,20].

Isolation, characterization and differentiation of dental stem cells are described [21]. However, in addition to their easy accessibility, the great problem is the very low quantity and the debatable quality of the produced cell lines. The amount of stem cells of the tooth pulp possessing the necessary cell markers and abilities is limited. The most recent research has shown that the stem cells are located in niches with low partial pressure of oxygen. The fact that hypoxia increases the likelihood of supporting cellular cell lines and the proliferation of multipotent precursors is an important progress in the field of stem cells research. Further research should precisely determine whether DPSCs respond differently to signal molecules after treatment by hypoxia as this fact open up new possibilities by changing their potential of differentiation. The vitro studies are necessary to allow physiological simulation of dental tissue and to establish accurate mechanisms of proliferation and differentiation of DPSCs in different conditions [22,23].

References

1. Vats A, Bielby RC, Tolley NS, Nerem R, Polak JM (2005) Stem cells. Lancet 366(9485): 592-602.
2. Škorić D, Balint B, Petakov M, Sindjić M, Rodić P (2007) Collection strategies and cryopreservation of umbilical cord blood. Transfus Med 17(2): 107-113.
3. Cordeiro MM, Dong Z, Kaneko T, Zhang Z, Miyazawa M, et al. (2008) Dental pulp tissue engineering with stem cells from exfoliated deciduous teeth. J Endod 34(8): 962-969.
4. Miura M, Gronthos S, Zhao M, Lu B, Fisher LW, et al. (2003) SHED: Stem cells from human exfoliated deciduous teeth. Proc Natl Acad Sci USA 100(10): 5807-5812.
5. Kerkis I, Kerkis A, Dozortsev D, Stukart-Parsons GC, Gomes Massironi SM, et al. (2006) Isolation and characterization of a population of immature dental pulp stem cells expressing OCT-4 and other embryonic stem cell markers. Cells Tissues Organs 184(3-4): 105-116.
6. d'Aquino R, Papaccio G, Laino G, Graziano A (2008) Dental pulp stem cells: a promising tool for bone regeneration. Stem Cell Rev 4(1): 21-26.
7. Perry BC, Zhou D, Wu X, Yang FC, Byers MA, et al. (2008) Collection, cryopreservation, and characterization of human dental pulp-derived mesenchymal stem cells for banking and clinical use. Tissue Eng Part C Methods 14(2): 149-156.
8. Shi S, Gronthos S (2003) Perivascular niche of postnatal mesenchimal stem cells in human bone marrow and dental pulp. J Bone Miner Res 18(4): 696-704.
9. d'Aquino R, Graziano A, Sampaolesi M, Laino G, Pirozzi G, et al. (2007) Human postnatal dental pulp cells co-differentiate into osteoblasts and endotheliocytes: a pivotal synergy leading to adult bone tissue formation. Cell Death Differ 14(6): 1162-1171.
10. Papaccio G, Graziano A, d'Aquino R, Graziano MF, Pirozzi G, et al. (2006) Long term cryopreservation of dental pulp stem cells (SBP-DPSCs) and their differentiated osteoblasts: a cell source for tissue repair. J Cell Physiol 208(2): 319-325.
11. Stevens A, Zuliani T, Olejnik C, LeRoy H, Obriot H, et al. (2008) Human dental pulp stem cells differentiate into neural crest-derived melanocytes and have label retaining and sphere-forming abilities. Stem Cells Dev 17(6): 1175-1184.
12. Gronthos S, Brahim J, Li W, Fisher LW, Cherman N, et al. (2002) Stem cell properties of human pulp stem cells. J Dent Res 81(8): 531-535.
13. Gronthos S, Mancani M, Brahim J, Robey PG, Shi S (2000) Postnatal human dental pulp stem cells (DPSCs) in vitro and in vivo. Proc Natl Acad Sci 97(25): 13625-13630.
14. Tobita M, Uysal AC, Ogawa R, Hyakusoku H, Mizuno H (2008) Periodontal tissue regeneration with adipose-derived stem cells. Tissue Eng Part A 14(6): 945-953.
15. Ueda M, Yamada Y, Ozawa R, Okazaki Y (2005) Clinical case reports of injectable tissue engineered bone for alveolar augmentation with simultaneous implant placement. Int J Periodontics Restorative Dent 25(2): 129-137.
16. Kang HK, Roh S, Lee G, Hong SD, Kang H, et al. (2008) Osteogenic potential of embryonic stem cells in tooth sockets. Int J Mol Med 21(5): 539-544.
17. de Mendonça Costa A, Bueno DF, Martins MT, Kerkis I, Kerkis A, et al. (2008) Reconstruction of large cranial defects in nonimmunosuppressed experimental design with human dental pulp stem cells. J Craniofac Surg 19(1): 204-210.
18. Morsczeck C, Schmalz G, Reichert TE, Volner F, Galler K, et al. (2008) Somatic stem cells for regenerative dentisty. Clin Oral Invest 12(2): 113-118.
19. He H, Yu J, Liu Y, Lu S, Liu H, et al. (2008) Effects of FGF2 and TGF beta1 on the differentiation of human dental pulp stem cells in vitro. Cell Biol Int 32(7): 827-834.
20. Prescott RS, Alsanea R, Fayad MI, Johnson BR, Wenckus CS, et al. (2008) In vivo generation of dental pulp-like tissue by using dental pulp stem cells, a collagen scaffold, and dentin matrix protein 1 after subcutaneous transplantation in mice. J Endod 34(4): 421-426.
21. Huang AH, Chen YK, Lin LM, Shieh TY, Chan AW (2008) Isolation and characterization of dental pulp stem cells from a supernumerary tooth. J Oral Pathol Med Mart 37(9): 571-574.
22. Agata H, Kagami H, Watanabe N, Ueda M (2008) Effect of ishemic culture conditions on the survival and differentiation of porcine dental pulp-derived cells. Differentiation 76(9): 9981-993.
23. Arthur A, Rychkov G, Shi S, Koblar SA, Gronthos S (2008) Adult human dental pulp stem cells differentiate toward functionally active neuron sunder appropriate environmental cues. Stem Cells 26(7): 1787-1795.

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