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Stem cell technology in diseases

Abstract

Administration of stem cells is a new therapy for the treatment of many diseases that are not curable by current therapies. Stem cells are formed at different places in the body and from the stem cells there are many other cells with specialized functions are generated. These include two main types of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blastocysts, and adult stem cells, which are found in various tissues. Stem cells are used for repairing the damaged tissues of the body. Recent research suggests that stem cells especially mesenchymal stem cells have immuno-modulatory characteristics. Stem cells have the properties of self renewal and multi-lineage differentiation capabilities, due to these properties transplantation of stem cells has a very promising way for treatment of many diseases.

Keywords: stem cell, autoimmune diseases, parkinson's disease, stroke, mesenchymal stem cells

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Introduction

Stem cells are unspecialized cells that are formed in embryos (blastocyst stage) and in various tissues of adults. Stem cells are found in multicellular organisms and divide mitotically. They have the property of self renew and can differentiate into different types of cells in appropriate conditions for specific functions. Stem cells are used for the repair of many organ and tissue in your body.[1] There are many different types of stem cells that come from different places in the body or are formed at different times in our lives. These include two broad types of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blastocysts, and adult stem cells, which are found in various tissues.[2]

Stem cells are the cells from which all other cells with specialized functions are generated. In the body or a laboratory, stem cells divide to form more cells called daughter cells and these daughter cells either become new stem cells (self-renewal) or become specialized cells (differentiation) with a more specific function, such as blood cells, brain cells, heart muscle or bone. They are used for purpose of repair of damaged tissues of the body. Recent research suggests that stem cells especially mesenchymal stem cells have immuno-modulatory characteristics. Due to this property, transplantation of MSCs useful in treating diseases which arise from immunological abuses.[1]

Due to self renewal and multi-lineage differentiation capabilities, transplantation of stem cells has emerged as a very promising way of treatment of many diseases. In stem cell therapy of different diseases there is either local delivery of stem cells to infected site or their systemic transfusion. The ability to differentiate into various lineages, stem cells hold therapeutic potential for treatment of many infectious and non- infectious diseases.[3]

Sources of stem cell

There are several sources of stem cell as under:

I. Embryonic stem cells

II. Tissue-specific stem cells

III. Mesenchymal stem cells

IV. Induced pluripotent stem cells

V. Amnoitic stem cells

Embryonic stem cells

Embryonic stem cells are obtained from the inner cell mass of the blastocyst, a mainly hollow ball of cells that, in the human, forms three to five days after an egg cell is fertilized by a sperm. A human blastocyst is about the size of the dot above this "i." The cells inside the inner cell mass will give rise to the more specialized cells that give rise to the entire body. However, when scientists extract the inner cell mass and grow these cells in special laboratory conditions, they retain the properties of embryonic stem cells.

Embryonic stem cells are pluripotent in nature and they can give rise to every cell type in the body, but not the placenta and umbilical cord. These cells are very important because they provide a renewable resource for studying normal development and disease, and for testing drugs and other therapies. Human embryonic stem cells have been derived primarily from blastocysts created by *in vitro* fertilization (IVF).[4]

Tissue-specific stem cells

Tissue-specific stem cells (also referred to as somatic or adult stem cells) are more specialized than embryonic stem cells. These stem cells are live in specific tissue or organ and they generate different cell types. For example, blood-forming (or hematopoietic) stem cells in the bone marrow can give rise to red blood cells, white blood cells and platelet. The main source of adult stem cells is bone marrow and these cells are used for the treatment of several conditions including spinal cord injury, liver cirrhosis, chronic limb ischemia and end stage heart failure.[5]

Mesenchymal stem cells

Mesenchymal stem cell or MSC are isolated from stroma, the connective tissue that surrounds other tissues and organs. These types of cells are called the "stromal cells". The first MSCs were discovered in the bone marrow and were shown to be capable of making bone,

cartilage and fat cells. After that, they have been grown from other tissues, such as fat and cord blood. Mesenchymal stem cell or MSCs have immunomodulatory properties and are useful in treating diseases which arise from immunological abuses. MSCs also used for the treatment of various diseases, including graft-versus-host disease, hematologic malignancies, cardiovascular diseases, neurologic diseases, autoimmune diseases, organ transplantation, refractory wounds, and bone/cartilage defects.[6]

Induced pluripotent stem cells

Induced pluripotent stem (iPS) cells are cells that have been derived by converting tissue-specific cells, such as skin cells, into cells that behave like embryonic stem cells. They are useful for developing and testing new drugs and therapies. Induced pluripotent stem cells have the same characteristics of embryonic stem cells, including the ability to give rise to all the cell types in the body. The first iPS cells were produced by using viruses to insert extra copies of genes into tissue-specific cells. Frozen blood samples can be used as a source of induced pluripotent stem cells.[7]

Amnoitic stem cell

Multipotent stem cells are also found in amniotic fluid. These stem cells are very active, expand extensively without feeders and are not tumorigenic. Amniotic stem cells are multipotent and can differentiate in cells of adipogenic, osteogenic, myogenic, endothelial, hepatic and also neuronal lines[8] (Table 1).

Table 1 Stem cell and their uses

Name of stem cell	Uses of stem cell
1. Tissue-specific stem cells	Spinal cord injury, liver cirrhosis, chronic limb ischemia and end stage heart failure
2. Mesenchymal stem cells	Graft-versus-host disease, hematologic malignancies, cardiovascular diseases, neurologic diseases, autoimmune diseases, organ transplantation, refractory wounds, and bone/cartilage defects
3. Induced pluripotent stem cells	Useful for developing and testing new drugs and therapies
4. Embryonic stem cells	They provide a renewable resource for studying normal development and disease, and for testing drugs and other therapies.

Role of stem cell in different diseases

Stem cell therapy for treatment of HIV infection

Stem cell therapy for treatment of HIV is under intensive investigation in recent times. Scientists are trying to reconstitute HIV-resistant lymphoid and myeloid system in experimental mice model to combat HIV infections,[9] engineered human hematopoietic cells to disrupt the CCR5 receptors which are utilized by viruses for their entry. When these engineered cells are transplanted to mice, they confer resistance towards the HIV infections. When CCR5 disrupted stem cells transplanted in a HIV patient, patient remained free of virus for 20 months even in absence of antiretroviral therapies.[10]

Hematopoietic stem cell therapy for autoimmune diseases

Autoimmune disease results when the immune system fails to recognize self cells or components and mistakenly attacks them. The most common autoimmune diseases include rheumatoid arthritis, systemic lupus erythematosis (lupus), type 1 diabetes, multiple sclerosis, Sjogren's syndrome and inflammatory bowel disease. In lupus autoimmune disease hematopoietic stem cell therapy destroy the mature, long-lived, and auto-reactive immune cells and develop a new, properly functioning immune system. In most of the cases the patient's own stem cells have been used in a procedure known as autologous (from "one's self") hematopoietic stem cell transplantation. First, patients receive injections of a growth factor, which coaxes large numbers of hematopoietic stem cells to be released from the bone marrow into the blood stream. These cells are harvested from the blood, purified away from mature immune cells, and stored. After sufficient quantities of these cells are obtained, the patient undergoes a regimen of cytotoxic (cell-killing) drug and/or radiation therapy, which eliminates the mature immune cells.

Then, the hematopoietic stem cells are returned to the patient via a blood transfusion into the circulation where they migrate to the bone marrow and begin to differentiate to become mature immune cells. The body's immune system is then restored. This replacement therapy may alter the patient's immune system. Richard Burt and his colleagues conducted a long-term follow-up (one to three years) of seven lupus patients who underwent this procedure and found that they remained free from active lupus and improved continuously after transplantation, without the need for immunosuppressive medications.[11]

In rheumatoid arthritis the chondrocytes, cells that build cartilage in joints, may provide stem cell-based treatment. These cells have been derived from human bone marrow stromal stem cells.[12] In addition to adult bone marrow as a source for stromal stem cells, human embryonic stem cells can differentiate into precursor cells believed to lead ultimately to the stromal stem cells.[13]

Stem cell therapy for treatment of malaria

Malaria, which is characterized by invasion of erythrocytes by Plasmodium, leads to extreme perturbation of hematopoiesis. Severe destruction of red blood cells causes anaemia, thus posing pressure on bone marrow to meet the requirement of myeloid cells. Scientists from National Institute for Medical Research, UK, have identified an atypical progenitor cells from malaria infected mice which can give rise to a lineage of cells capable of fighting this disease.[14] Transplantation of these cells into mice with severe malaria helped mice recover from the disease. Other reports also supports stem cell therapy for malaria treatment.[15] Stem cells can also be engineered to produce erythrocytes with modified hemoglobin as its variants are associated with protection from malaria.

Stem cells in treatment of neurological disorder

Alzheimer's disease

Alzheimer's is a fatal disease in which progressive cell degeneration take place that leads to the loss of brain cells that control thought, memory and language. Stem cells transplanted from a patient's bone marrow to the brain will take over the functions of

damaged cells and help in treatment of Alzheimer's disease (AD). Neural stem cell (NSC) grafts is a new strategy for the treatment of many disorders of the central nervous system including AD, with the possibility of providing a more permanent remedy than present drug treatments. After grafting, these cells have the capacity to migrate to lesioned regions of the brain and differentiate into the necessary type of cells that are lacking in the diseased brain, supplying it with the cell population needed to promote recovery.[16]

Parkinson's disease

Stem cell therapy in Parkinson's Disease include isolation of adult stem cells from the patient's brain, they were then cultured *in vitro* and encouraged to turn into dopamine-producing neurons. As soon as the cells were producing dopamine they were then re-injected into the man's brain. After the transplant, the man's condition was seen to improve and there is reduction in the trembling and muscle rigidity associated with the disease. Brain scans taken 3-months after the transplant revealed that dopamine production had increased by 58%, however it later dropped but the Parkinson's symptoms did not return. This is the first human study to show that stem cell transplants can help to treat Parkinson's disease.[17]

Stroke

During and after a stroke, certain cellular events take place that lead to the death of brain cells. In patients with ischemic stroke, the autologous MSCs are used for the treatment therapy. There are 30 patients with cerebral infarcts within the middle cerebral arterial territory Serial evaluations showed no adverse cell-related, serological, or imaging-defined effects. In patients with severe cerebral infarcts, the intravenous infusion of autologous MSCs appears to be a feasible and safe therapy that may improve functional recovery.[18]

Multiple sclerosis

Malignant multiple sclerosis (MS) is a rare but clinically important subtype of multiple sclerosis (MS). A experiment treatment of 24 patients (14 women, 10 men) with relapsing-remitting Multiple Sclerosis, in the course of 2-8 years was done. For treatment, the embryonic stem cell suspensions (ESCS) containing stem cells of mesenchymal and ectodermal origin are used. Suspensions were administered in the amount of 1-3ml, cell count being 0,1-100x105/ml. In the course of treatment, applied were 2-4 different suspensions, mode of administration being intra cavitary, intravenous, and subcutaneous. After treatment, syndrome of early post-transplant improvement was observed in 70% of patients.[19]

Conclusion

Stem cell based therapies are the novel techniques that are used for the treatment of many diseases. Mesenchymal stem cells are the main cell type being used due to their longevity and less ethical issues. Stem-cell-based technology is the best possibility for the future. These include the ability to reproduce human tissues and potentially repair damaged organs (such as the brain, spinal cord, vertebral column the eye). The ability to differentiate into various lineages, stem cells therapy is potential for treatment of many infectious and non- infectious diseases.

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Conflict of interest

The author declares no conflict of interest.

References

1. Ramesh CR, Debapriya B, Gobardhan Das. *Stem cells in infectious diseases*. International Centre for Genetic Engineering and Biotechnology. India; 2012. p. 416–426.
2. Becker AJ, McCulloch EA, Till JE. Cytological demonstration of the clonal nature of spleen colonies derived from transplanted mouse marrow cells. *Nature*. 1963;197(4866):452–454.
3. Barry FP, Murphy JM. Mesenchymal stem cells: clinical applications and biological characterization. *Int J Biochem Cell Biol*. 2004;36(4):568–584.
4. Thomson JA, Itskovitz Eldor J, Shapiro SS, et al. Blastocysts embryonic stem cell lines derived from human. *Science*. 1998;282(5391):1145–1147.
5. Narasipura SD, Wojciechowski JC, Charles N, et al. P–Selectin coated microtube for enrichment of CD34+ hematopoietic stem and progenitor cells from human bone marrow. *Clin Chem*. 2008;54(1):77–85.
6. MM Lalu, McIntyre L, Pugliese C, et al. "Safety of cell therapy with mesenchymal stromal cells (SafeCell): a systematic review and meta–analysis of clinical trials". *PLoS One*. 2012:7(10).
7. *Frozen blood a source of stem cells, study finds*. 2010.
8. De Coppi P, Bartsch G, Siddiqui MM, et al. Isolation of amniotic stem cell lines with potential for therapy. *Nature Biotechnology*. 2007;25(5):100–106.
9. Holt N, Wang J, Kim K, et al. Human hematopoietic stem/progenitor cells modified by zink–finger nucleases targeted to CCR5 control HIV–1 *in vivo*. *Nature Biotechnol*. 2010;28(8):839–847.
10. Hütter G, Nowak D, Mossner M, et al. Long–term control of HIV by CCR5 Delta32/Delta32 stem–cell transplantation. *N Engl J Med*. 2009;360(7):692–698.
11. Traynor AE, Schroeder J, Rosa RM, et al. Treatment of severe systemic lupus erythematosus with high–dose chemotherapy and haemopoietic stem–cell transplantation: a phase I study. *Lancet*. 2000;356(9231):701–707.
12. Pittenger MF, Mackay AM, Beck SC, et al. Multilineage potential of adult human mesenchymal stem cells. *Science*. 1999;284(5411):143–147.
13. Schuldiner M, Yanuka O, Itskovitz Eldor J, et al. Effects of eight growth factors on the differentiation of cells derived from human embryonic stem cells. *Proc Natl Acad Sci USA*. 2000;97(21):11307–11312.
14. Belyaev NN, Brown DE, Diaz AI, et al. Induction of an IL7–R(+)c–Kit(hi) myelolymphoid progenitor critically dependent on IFN–gamma signaling during acute malaria. *Nat Immunol*. 2010;11(6):477–485.
15. Saei AA, Ahmadian S. Stem cell engineering might be protective against severe malaria. *Bioscience Hypotheses*. 2009;2(1):48–49.
16. *Current Alzheimer Research*. 2005;95(17):79–95.
17. Paul R Sanberg. Neural stem cells for Parkinson's disease: To protect and repair. *PNAS*. 2007;104(29):11869–11870.
18. *Neurosurg Focus*. American Association of Neurological Surgeons. 2005:19(6).
19. Ul Hassan A, Hassan G, Rasool Z. Role of stem cells in treatment of neurological disorder. *Int J Health Sci*. 2009;3(2):227–233.