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Research article

Stem cell & their role in Diabetes

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ABSTRACT

Stem cell therapy is miraculous research in the field of medical sciences. It is very useful in future for the treatment of various diseases. According to recent stem cell studies, stem cell can cure many life threatening diseases (such as diabetes, cancer, brain diseases, HIV etc.).[1,2]Stem cell have two specific property one is differentiated into different body cells and another is regenerate the damaged tissue or organ. These properties of stem cell are basically used in the therapy of various diseases, also in treatment of diabetes. Stem cells are obtained from different sources (bone marrow, embryo, skin stem cells etc.). In diabetes stem cell regenerate the damaged Beta cells present in islets of langerhans of pancreas and helps in to cure diabetes. In present time stem cell therapy decreases the uses of anti-diabetic drugs in many patients. In future this therapy will widely use for treatment of various diseases including diabetes.

Keywords: Stem Cell; Anti-Diabetic Drugs; Langerhans of Pancreas; Diabetes.

INTRODUCTION

Stem Cell

Stem cells are the _basic cells‘ of multicellular organism, they are the foundation cells for every organ, tissue and cell of the body which can divide (through mitosis) and differentiate in any type of cell. They act as reserve cell with the capacity to grow and multiply to replace dead or damaged adult cells. These cells migrate to injured areas within the body and get transplanted and transform themselves into new tissue cells that replace the damaged ones. Stem cells have the capacity to multiply and renew themselves . Stem cell can form nerve cells, muscle cells and blood cells which cannot multiply themselves and have limited life spans. Stem cells circulate and function to replace dysfunctional cells, naturally maintaining optimal health. Current medical research is focused on two particular types of stem cells - adult and embryonic. Out of the three types of stem cells, two are able to develop into any type of cell within the human body. These two are called totipotent and pluripotent respectively. Stem cells that are pluripotent have the capability of forming virtually all the possible tissue types found in human beings. These stem cells can only be found in a particular stage (a blastocyst) in human embryos. Multipotent stem cells are partially differentiated, so that they can form a restricted number of tissue types. Multipotent stem cells can be found in the fetus, in numerous adult tissues and umbilical cord blood. The third type of stem cells have less regeneration potential and can only develop into a limited number of other types of cells [1].

Stem Cell Differentiation

First stem cells originate within the developing embryo, develops complete human being via a several steps. A different type of stem cells (embryonic, adult etc.) has different differentiating potential. Such as stem cells from the bone marrow can develop into cardiac muscle as well as liver, brain, nerve, fat and skin tissue. These cells are progenitor cells that lead to creation of new cells and are thus called as generative cells. Hematopoietic stem cells are found in the bone marrow and give rise to all the blood cell types [2].

Embryonic Stem Cells

Embryonic stem cells are generally found in blastocyst. A blastocyst is a pre- implantation embryo. It is developed after five days of the fertilization of an egg by a sperm. It contains the essential material for the development of a complete fetus. The blastocyst is a mostly hollow sphere of cells. In its interior is the inner cell mass, which is composed of 30- 34 cells that are referred to by scientists as pluripotent because they

can differentiate into all of the cell types of the body.

In normal development, the blastocyst would implant in the wall of the uterus to become the embryo and continue developing into a mature organism. Its outer cells would begin to form the placenta and the inner cell mass would begin to differentiate into the progressively more specialized cell types of the body.

When the blastocyst is used for stem cell research, scientists remove the inner cell mass and place these cells in a culture dish with a nutrient-rich liquid where they give rise to embryonic stem cells. Embryonic stem cells seem to be more flexible than stem cells found in adults, because they have the potential to produce every cell type in the human body. They are also generally easier to collect, purify and maintain in the laboratory than adult stem cells [3].

Sources

In Vitro Fertilization: The source of blastocysts for stem cell research is from in vitro fertilization (IVF) clinics. The process of IVF requires the retrieval of a woman's eggs via a surgical procedure after undergoing an intensive regimen of "fertility drugs", which stimulate her ovaries to produce multiple mature eggs. When IVF is used for reproductive purposes, doctors typically fertilize all of the donated eggs in order to maximize their chance of producing a viable blastocyst that can be implanted in the womb. Because not all the fertilized eggs are implanted, this has resulted in a large bank of "excess" blastocysts that are currently stored in freezers around the country. The blastocysts stored in IVF clinics could prove to be a major source of embryonic stem cells for use in medical research. However, because most of these blastocysts were created before the advent of stem cell research, most donors were not asked for their permission to use these left-over blastocysts for research. The IVF technique could potentially also be used to produce blastocysts specifically for research purposes.

Nuclear Transfer: It is another technique to produce embryonic stem cells. In this technique nucleus (genetic material) of one cell is transfer by the nucleus of an already differentiated adult cell-for example, a skin cell-into a donated egg that has had its nucleus removed. This egg, which now contains the genetic material of the skin cell, is then stimulated to form a blastocyst from which embryonic stem cells can be derived. The stem cells that are created in this way are therefore copies or "clones" of the original adult cell because their nuclear DNA matches that of the adult cell. According to recent studies nuclear transfer process is not successful in human being, but progress in animal research suggests that scientists may be able to use this technique to develop human stem cells in the future.

Scientists believe that if they are able to use nuclear transfer to derive human stem cells, it could allow them to study the development and progression of specific diseases by creating stem cells containing the genes responsible for certain disorders [4, 5].

Fetal Stem Cells

The developing organs and tissues in a fetus contain a relatively large supply of stem cells because they are needed for growth and maturation. The difference between embryonic stem cells and fetal stem cells is the fetal stem cells have matured part of the way to mature cells. For example, if it takes 20 maturation steps for an embryonic stem cell to turn into a mature skin cell, fetal skin cells are at step 10; they are not as mature as adult skin stem cells, but they are past the stage of becoming committed to the liver. There are currently several problems with the therapeutic use of fetal stem cells. First, fetal tissue research is highly controversial. There are significant moral and ethical issues with the use of fetal tissues for research purposes. Second, the numbers of stem cells in fetal tissues may not be sufficient for the therapeutic needs of adults. Thus, methods need to be developed to greatly expand the supply of fetal stem cells if they are to be therapeutically useful. Third, tissue rejection problems similar to those encountered in kidney and heart transplants may limit the usefulness of fetal stem cells.

Umbilical cord stem cells

Cells in the umbilical cord are "multipotent" and can give rise to all the cells in normal bone marrow. Scientists are working to discover if cord blood stem cells can multiply and become other types of adult stem cells. For this reason many new parents have their new baby's umbilical cord blood cryopreserved for potential future use.

Adult Stem Cells

Adult stem cells are produce after differentiation of pluripotent embryonic stem cells. Adult stem cells are unipotent in nature, produce only one type of cells, generate only their own kind. Such as skin wounds are repaired by skin stem cells, similarly, liver damage is repaired by liver stem cells. Adult stem cells are also known as somatic (means "of the body") stem cells and germline (giving rise to gametes) stem cells, they can be found in children, as well as adults. The use of adult stem cells in research and therapy is not as controversial as the use of embryonic stem cells, because the production of adult stem cells does not require the destruction of an embryo. Additionally, in instances where adult stem cells are obtained from the intended recipient (an autograft), the risk of rejection is essentially non-existent. Recent studies show that some adult stem cells show pluripotent properties. For example, some experiments have suggested that blood stem cells isolated from adult mice may also be able to produce liver, muscle and skin cells, but these results are not yet proven and have not been demonstrated with human cells. Adult stem cells are found very deep within organs; they are covered by many ordinary cellsand may help replenish some of the body's cells when needed. In fact, some adult stem cells are currently being used in therapies. Adult stem cells are generally divided according to their origin such as mesenchymal stem cell (adipose- derived stem cell), endothelial stem cell (endothelial-derived stem cell), dental pulp stem cell (dental pulp-derived stem cells), skin stem cell (skin-derived stem cell) etc [6].

Induced Pluripotent Stem Cells

These are not adult stem cells, but rather adult cells (e.g. epithelial cells) reprogrammed to give rise to pluripotent capabilities. Using genetic reprogramming with protein transcription factors, pluripotent stem cells equivalent to embryonic stem cells have been derived from human adult skin tissue**.**

Mesenchymal Stem Cells

The reasons behind the inclusion of Mesenchymal stem cells (MSCs) are simply that they are currently the most prolific source of potential therapeutic strategies for human disease and numerous clinical trials are underway using this versatile source of stem cells. MSCs may be isolated from human bone marrow and the first experimental evidence for the existence of a stem cell population in this tissue compartment other than the human stem cells (HSCs) arose in the 1960.

Stem Cell Therapy

Stem cell therapy is also called regenerative medicine. According to recent studies stem cells are may be used in various diseases and some diseases are successfully treated by stem cells. Cell-based therapy is an empirical therapy. In this therapy stem cells are induced to differentiate into the specific cell type required to repair the damaged or destroyed cells or tissues. Treatment can be divided in two types - Autologous stem cell therapy and Allogenic stem cell therapy.

Autologous stem cell therapy

This therapy includes the use of patients own stem cells which are obtained from blood, bone marrow etc.

Allogenic stem cell therapy

In this therapy a person is cured with the help of donated stem cells. However, in number of diseases or disorders, allogenic (foreign) stem cells may be rejected by the body. So far this therapy is not legally accepted in India.

The over view procedure of stem cell therapy in Chaitanya stem center.

Thorough physical and blood examination will be done by panel of consultants. Patient will be asked to get PET scan and blood investigations to diagnose neurological defect in brain to check eligibility for the therapy. Next day stem cell collection will be done. The Chaitanya stem Cell procedure employs autologous adult stem cells and thus these cells are collected from patient own bone marrow. Sample of the same will be send to laboratory where the stem cells will be separated from bone and the quality of the same will be checked.

First dose of isolated stem cell will be send back to the hospital for intra-thecael / intra-lesional injection. Once the procedure is completed patient will be discharged the next day. However, patients are expected to come for regular follow ups recommended by doctor‘s.

Patient will be called for second dose of Stem Cell Injection after 3 month or as per doctor‘s instructions and if required patient may need to come for a 3rd dose as well. To monitor the progress of stem cell implantation, patient may need to repeat the PET scan.

The treatment pattern may differ as per patient‘s status and disease.

Therapy

Clinical improvements are generally noted for a period of 12-18 months after the start of Stem cell therapy.

Significant positive change is usually demonstrated on the video after every 12-18 months. Periodically the clinical and psychological evaluation including video recording is also done to note the improvement.

Parents have seen improvement within four-eight weeks of Stem Cell Therapy. Improved pronunciation, speech and ease of movements, bladder control, reducedirritability, reduced hyperactivity and reduced spasticity are some of the signs of improvement.

Development in speech, volume and pronunciation in understanding, expression & emotions are other positive signs observed after Stem Cell Therapy.

Also patients progressively become aware of time as there is development in general sense. Other factors like looks, trunk and control over the neck also significantly improve [7].

CONCLUSION

Till date, the recent advancements and researches have demonstrated that stem cell therapy helps in regeneration of beta cell, present in islet of langerhans of pancreas, and improves blood supply of damaged pancreas. Hence in future, stem cell therapy can cure diabetes with minimal or no adverse effect. Stem cell research focuses on stem cells, which have a capacity to regenerate. Stem cells circulate and function to replace dysfunctional cells, naturally maintaining optimal health. Current medical research is focused on two particular types of stem cells - adult and embryonic. Totipotent and pluripotent stem cells are able to develop into any type of cell within the human body.

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