



Stem cell research: A new ray of hope

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Abstract

Stem cell research has been gaining popularity across the globe in recent years with regenerative medicine that is involved in cloning and gene line engineering. The study of stem cell biology requires more human pluripotent and multipotent stem cells. As the stem cell biology varies in humans and mice, human stem cells are required. Citizens should participate in discussing ethical concerns and policy issues regarding stem cell research. There should be specific protocols to enhance production, survival, and integration of transplanted stem cells. This review discusses about the advantages, challenges of stem cell research with strategies to overcome the hurdles.

Introduction

Stem cell research promises cure for numerous human diseases by tissue regeneration and repair. At present, the use of stem cell research to achieve full therapeutic potential with their possible application in regenerative medicine has been much touted, but many obstacles must still be overcome. It is one of the most controversial areas in contemporary biology and medicine.^[1] In European countries like Belgium, Sweden embryo research is allowed, whereas in Austria, Italy, Ireland, and Spain, it is strictly banned. Few countries like the Netherlands allow stem cell research but prohibit reproductive cloning. Adequate clinical trials must be carried out to ensure safe and efficient stem cell therapy.^[2]

Advantages of Stem Cell Therapies

The most promising future strategies in the medical field lie on stem cell-based therapies. With the help of regenerative medicine and therapeutic cloning, any developmental, traumatic, degenerative, or cancerous conditions may be treated.^[3] Transplantation of entire organs, rebuilding of injured tissues, replacement of senescent, and used up somatic cells will definitely improve the quality of life. New researches are conducted globally using stem cells to treat Parkinson's disease, Alzheimer's disease, spinal cord injuries, diabetes, heart ailments, cancer, etc.^[4] It may be used to learn embryological development

of various organs, cell development, and pathogenesis of diseases. Stem cell research also benefits the study of human developmental stages which cannot be studied directly in an embryo, especially in detecting birth defects and fertility issues. A more comprehensive understanding of normal development will ultimately allow the prevention and treatment of abnormal human development. It can be used for clinical drug trials to screen the efficiency of potential new drugs and prevent animal studies.^[4,5]

Stem cells are used for tissue engineering to repair or replace a diseased tissue using stem cells from the patient's own body. It is claimed that many diseases can be treated and transplants can be carried out using this technique. Certain organs and limbs can be grown in a laboratory using stem cells and then transplanted. Stem cell banking is a new emerging field that enables one to get stem cells through umbilical cord blood collected at birth. This uncorrupted DNA at birth can be replicated into large number for future uses. Mesenchymal stem cells which are majorly used in stem cell therapies have the ability to differentiate into osteoblasts, tenocytes, and chondrocytes, hence, beneficial in treating bone disorders too. Osteogenesis imperfecta, hypophosphatasia, spinal disorders, etc., which earlier had no treatments are finding new ray of hope through stem cell therapies. Prolonging of human lives with anti-aging techniques may be possible in the future with stem cell research. Stem cell research will make treatments more affordable and easily accessible to people in the future.^[6,7]

Embryonic and Adult Stem Cells

Embryonic stem cells are pluripotent in nature and are derived during the blastocyst stage of early development. Adult stem cells are undifferentiated cells present in the adult tissues.^[8]

Advantages of embryonic stem cells

Embryonic stem cells are very flexible and have the potential to develop into any cell type within the body and are more versatile than adult stem cells. These cells are immortal and can provide unlimited supply of cells with defined characteristics. These cells are easily available from *in vitro* fertilization (IVF) clinics. They are highly malleable and contribute to germ lines.^[9]

Disadvantages of embryonic stem cells

It is difficult to establish specialized cell lines from embryonic stem cells. The immunogenic embryonic stem cells may likely be rejected after a transplant due to incompatibility between donor and recipient as it may trigger an immune reaction. These cells may undergo tumorigenesis or may destruct developing human life. The skill to acquire the right amount of cells at the right stage of differentiation is yet to be mastered. As stem cell research is still ongoing, the long-term effects of these techniques and therapies are not yet known. It is feared that in future the cell line cultures may undergo chromosomal mutations as they age. They may not provide a solution to all kinds of ailments.^[9,10]

Advantages of adult stem cells

Recently, scientists have been able to isolate adult-type stem cells that are as flexible as embryonic type from bone marrow and umbilical cord. It is easy to harvest from skin, muscle, fat, etc. As they are specialized, inducement may be simpler. As the patient receives stem cells from his own body, there will not be any immune-related transplant rejection. There is no harm to the donor and they do not form tumors. They can be autotransplanted; they have the ability to produce blood cells on transplantation with unlimited growth potential.^[9,11]

Disadvantages of adult stem cells

Adult stem cells can be obtained only in small quantities and may not have infinite survival ability like embryonic stem cells. There are still many adult-type stem cells that are not as flexible as embryonic stem cells and may pose difficulty in reprogramming to other tissue types. Isolation and purification are relatively complex.^[9,11]

Ethical Concerns with the use of Stem Cells

Although stem cell science has promised new advancements in medicine, there has been extreme politicization in local, national, and global domains. The belief that human life starts at conception and that an embryo should be given the same moral status as a person is an argument against stem cell studies.

Based on legal, ethical, moral, and religious grounds, stem cell studies were opposed stating that embryo has certain rights and interests that must be respected. It is argued that the process of the derivation of pluripotent stem cell lines using a blastocyst to remove the inner cell mass to obtain embryonic stem cells is equivalent to murder. There are debates about exactly when the human life starts, whether it is at the first opportunity of cell growth or is it when the embryo attaches to the uterus wall. It is also discussed whether new cell lines can be taken from the excess embryo produced during IVF procedures or whether these embryos can be considered as organ donors.^[12]

Many people hold a middle ground regarding stem cell research. There is a new technique called somatic cell nuclear transfer technique for creating embryos that do not involve fertilization of an egg by a sperm. The use of these kind of embryonic cells for research is debatable. Some feel that as long as there is an informed consent from the couple who are donating the embryo for research and if there is relevant scientific justification, then the stem cell research can be carried out. These are few of the ethical dilemmas faced by stem cell researchers around the globe.^[13]

Overcoming the Challenges

Few studies have been carried out recently where the embryonic stem cells were allowed to differentiate before the process of transplantation and this reduced the incidence of tumor formation. It was seen that addition of certain growth factors to transplanted cells stimulated them to produce only specific cell type of interest. To overcome the problem of embryonic transplant rejection by the patient, genetic match can be performed between donor embryo and the recipient. Genetic match can be induced to create histocompatible stem cells through somatic cell nuclear transfer. These are few steps taken to overcome the challenges faced by stem cell research.^[4,14,15]

Stem Cell Research in India

Stem cell research in India is still in its initial stages and has already undergone tremendous flux with the regulating bodies under scrutiny and criticism from the government, media houses, and people. In 2017, Indian Council of Medical Research and Department of Biotechnology (ICMR-DBT) have drafted the new ICMR-DBT guidelines on stem cell research.^[16-18] Indian Medical Association in agreement with the guidelines has provided the procedural clarity. In India, stem cell research can only be conducted as clinical trials with approval from Central Drugs Standard Control Organisation. Any hospitals/clinics advertising treatments using unapproved therapies are strictly banned. Globally recognized hematopoietic stem cell transplantation is allowed in our country to treat few diseases such as acute myeloid leukemia and Burkitt's lymphoma. Numerous clinics here offer treatments for muscular dystrophy, cerebral palsy, Parkinson's disease, spinal cord injury, etc.,

without approval from medical council. However, since there have been no reported cases of patient harm, no legal action has been taken so far. Government is designing new policies such as regulating tax regimens and financial markets to improvise the global competitive position of India.^[19,20]

Conclusion

Stem cell research and therapies are promising new strategies for the treatment of various ailments and are gaining global interest. With a better understanding of the stem cell biology, along with proper legal public policies and ethical guidelines, safe and reliable treatments can be offered in the future. Steps should be taken to increase the awareness and public knowledge by informed public discussions that involve broad section of society. New research and development in stem cell research, application of new technologies will significantly improve the quality of life.

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