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Emerging Paradigms in Regenerative Medicine: Stem cell Therapies

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Abstract :

Stem cell research is now emerging as most exciting and promising area of modern biomedical research which has enormous potential for easing suffering for many diseases such as Parkinson's, Alzheimer's, Diabetes,Cancer and many more. This is now recognized most promising alternate therapeutic choice for some of the diseases which currently have no other option of an effective therapy. The Stem cell therapy is now strengthened by cutting- edge technologies and rigorous standards of clinical research thus rapidly progressed from bench to the clinic.

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Introduction:

Regenerative Medicine is a rapidly advancing and promising area of medicine with the potential to fully restore damaged tissues and organs. As such, offering solutions and hope for people who have conditions that are beyond repair today. This developing aspect of medicine holds the potential of decisive, reasonable health care solutions that heal the body from within.

Regeneration involves transplantation of specific types of cells or cell products to diseased tissues or organs, where they will ultimately restore tissue and organ function. This can be achieved through cell-based therapy or by utilizing cell products.

There is a significant deterrence to the accomplishment of transplantation of any cells, including stem cells and their derivatives which is the immune-mediated rejection of foreign tissue by the recipient's body. In recent procedures of stem cell transplantation with bone marrow and blood, achievement can axis on selection of a perfect match between donor and recipient tissues as well as the use of immunosuppressive drugs. However, this approach often has severe and life-threatening side effects.

Stem cell research is on the cutting edge of regenerative medicine. Today, new advances in stem cell research are giving new hope to people who are affected by these diseases. Stem cell-based therapies are now emerging paradigms to overcome the problem of tissue rejection. New strategies are being explored to control the growth of these cells that can be used as therapeutics for a wide range of chronic diseases such as diabetes, and degenerative nerve, bone and joint conditions including life-threatening diseases.

Stem Cell Therapy (SCT) is now widely accepted an intervention therapeutic choice for some of the diseases which currently have no other option of an effective therapy. SCT utilize targeted administration approaches and newest regulatory compliances to ensure the safest and most effective stem cell therapies which can accurately benefit from debility to significantly improvement in one's quality of life. SCT offers to introduce new stem cells into the damaged organ site of the body where it is most desirable to facilitate the healing and regeneration of its prevailing damaged tissue in order to treat disease or injured cells. SCT has huge potential for alleviating suffering for many diseases such as Parkinson's, Alzheimer's, Diabetes, Cancer and many more.

Although, enormous progress in understanding basic cancer biology is achieved but the unfortunate pragmatism is that most newly established anticancer agents are still failing in the clinical trials. It may possibly be linked with poor drug efficacy, or alternatively their significant side effects. It frequently occurs due to some factors which may possibly play a dynamic role, including the use of inappropriate preclinical models for assessment of treatment protocols and a lack of reliable biomarkers in the accurate selection of the patients. We are optimistic to overcome these technical impediments? The possibility to overcome these impediments lies in Patient-derived Xenografts (PDXs), which will evolve the new gold standard models for oncological drug development.

Numerous pre-clinical and clinical research conducted in the recent past provided strong evidences on optimistic application of stem cell therapies in the treatment of some major diseases aimed at lung, kidney, liver and heart failures, stroke or brain injury including cancer.[1] Most of the stem cell treatment modalities are being explored utilizing an Intravenous (IV) or direct injections. Furthermost, potential stem cell treatment is achieved through customized treatment plan. Since the disease status of the patient differ each other, the treatment strategy must be personalized around their specific disease related complications and symptoms of each individual patient.

In recent past, stem cell therapy is now strengthened by cutting- edge technologies and rigorous standards of clinical research thus rapidly progressed from bench to the clinic. New approaches are also being explored to control the growth of these cells that can be used as therapeutics for a range of life -threatening diseases. A variety of stem cell-based strategies are currently being discovered for cell replacement. Re-populating the endogenous tissue-specific stem cells that are already present in the dysfunctioning tissue holds great potential. Allogeneic transplantation of Hematopoietic Stem cells (HSCs) is commonly used in the treatment of genetic disorders such as thalassemia and immunodeficiencies. Though ethically debatable, somatic cell nuclear transfer, a

technique that produces a lineage of stem cells that are genetically matching to the donor, promises such a benefit.

Mesenchymal stem cells (MSCs) have been shown to be competent in the treatment of many diseases, including both immune disease and non-immune diseases.[2] However, there are still foremost questions regarding the optimal dosages of MSCs, routes of administration, best engraftment time and the fate of the cells after infusion.[3] Autologous transplantation of MSCs in the musculoskeletal system has been effectively explored in the regeneration of periodontal tissue defects, diabetic critical limb ischemia, bone damage caused by osteonecrosis, burn-induced skin defects, myocardial infarction2 including the treatment of urinary incontinence and Duchenne muscular dystrophy.[4]

Induced pluripotent stem cells (iPSCs) are also being considered rational substitute for the expansion of pertinent human cell models. In-vitro differentiation of human pluripotent stem cells (hPSCs) to HSCs is expected for a long time that would essentially benefit cancer patients requiring myeloablative therapy who lack an optimal HSC donor.[5] HSCs therapy as replacement possibly will primarily alter the patient's immune system hence hold a future promise to the treatment of cancer,[6] autoimmune disorders which could effectively destroy the mature, long-lived and autoreactive immune cells or to generate a new, properly functioning immune system. Human iPSC-derived hepatocytes are being exploited for the study of metabolic functions linked with glucose regulation, mitochondrial function, and lipid dysregulation. However, it is an important consideration is the age of both the donor tissue and the recipient environment before opting any stem cell transplantation-based strategy.

Recent advent of Gene editing holds great promise for evolving the more efficacious treatment modalities of stem cell therapies in regenerative medicine for inherited genetic disorders, infectious disease, degenerative disorders, autoimmunity, and cancer. Many vital questions remain to be clearly elucidated about precise genome editing to eliminate off target effects while preserving full on-target activities in stem cell differentiation. The prospects for applying genome editing in clinical therapies to provide long-lasting protection, are also challenging. Gene editing is highly pertinent for hPSCs when the tissue-specific genes responsible for diseases may not express. Other options for this purpose include genetic manipulation of the stem cells and the development of a very large bank of embryonic stem cell lines.

There is much to be done to resolve vibrant issues viz. Whether the internal and external signals for cell differentiation similar for all kinds of stem cells or not? Can specific group of signals be identified that facilitate differentiation into specific cell types? Whether there is any possible age-related accumulation of somatic mitochondrial DNA mutations in adult-derived iPSCs? Further the strategies that exploit pluripotent stem cells and their differentiation approaches for transplantation is beneficial over conventional cell therapies?

Newer high-throughput imaging based technologies specifically designed for the discovery of novel stem cell differentiation protocols are being optimized and also established to culturing or utilizing stem cells for various applications for regenerative medicine and drug discovery. Now Bioreactor automation technology facilitated a broad avenue which could efficiently expand the growth of the stem cells, while maintaining their undifferentiated characteristics under safe Good Manufacturing Practices (GMP) conditions. Indeed, this will greatly improve the management of the stem cell cultures in regular atmosphere, thus facilitating a wide spectrum of clinical applications.

It is sincerely anticipated that the contentious efforts to explore newer technologies will flourish our vision to unravel unanswered questions to define a model in controlling immune rejection, to manipulate the genetic makeup of stem cells, co-transplantation of mesenchymal and hematopoietic stem cells, somatic cell nuclear transfer or precise monitoring differentiation in stem cell in the laboratory conditions. Such combative approaches will facilitate to grow cells or tissues that could be used for development of stem cell-based therapies or drug screening.

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