Stem Cell Therapy for Type II Diabetes

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What is Stem Cell Therapy?

Stem Cell Therapy, also known as regenerative medicine, uses stem cells to repair the response of diseased or injured tissues.

Stem cells are cells found in nearly all tissues of the human body. These cells can self-renew and become other cells through differentiation, allowing labs to cultivate specific cells for therapeutic purposes. As these cells can be implanted into patients to regenerate damaged tissues, they hold the potential to replace organ transplantations. The most versatile type of stem cells, Embryonic Stem Cells (ESCs) , come from blastocysts (3-5 day old embryos) and are capable of developing into all cell types of a developing fetus.

Stem cell transplants have been ongoing for many years, particularly hematopoietic stem cell transplants, which use stem cells from the bone marrow to replace cells damaged by chemotherapy or diseases. Hematopoietic stem cell transplants have been useful in the treatment of several different kinds of cancers, including leukemia, lymphoma, neuroblastoma, and multiple myeloma.

Researchers have utilized stem cells to engineer organoids—miniaturized, simplified versions of organs used for drug screening and disease modeling. These organoids allow scientists to identify deficiencies in patients' cells and test potential treatments.

Since stem cell therapy carries a risk of immune rejection, patients must be on immunosuppressive drugs to prevent the immune system from identifying the cells as foreign. In certain cases, however, this is unnecessary, as stem cells generated through SCNT or iPS cell technology can match closely to the receiver’s genetics.

What is Type II Diabetes?

Type II Diabetes (T2D) refers to the chronic condition of hyperglycemia, or high blood sugar levels (>126 mg/dL). The condition occurs when the pancreas does not generate sufficient insulin (a

hormone required that helps our bodies convert glucose into energy), or when the body cannot use insulin properly. The primary cause of T2D is insulin resistance, where cells in the muscles, fat, and liver don't respond as they should to insulin. This causes the pancreas to initially generate excessive insulin to compensate for increasing glucose levels. Over time, however, β-cell mass reduces, leading to insufficient insulin production and elevated blood glucose levels.

T2D is very common, with 6.3% of the world's population and 34 million people in the United States facing this chronic lifestyle disease. The risk factors for developing T2D include having a family history of the condition, being over 45 years old, being overweight, leading a sedentary lifestyle, experiencing high blood pressure or elevated cholesterol levels, and having Polycystic Ovarian Syndrome. Complications arising from T2D include, but are not limited to, cardiovascular diseases, retinopathy, macular edema, cataracts, glaucoma, blindness, nephropathy, neuropathy, etc. Over 30% of T2D patients rely on insulin treatment, so cadaveric islet transplantation becomes an effective treatment option, ultimately improving metabolic control, kidney function, and long-term survival.

Types of Stem Cells that Could Mitigate T2D

Research suggests that the stem cell types listed below could be effective for stem cell therapy aimed at potentially reducing T2D:

1. **ESCs (Embryonic Stem Cells)**

   Embryonic Stem Cells have been used to develop into β - cells, which make insulin. However, obtained from the ICM (inner cellular mass) of gastrula (early multicellular embryos), there have been ethical considerations regarding the use of ESCs, in particular about the destruction of early stage embryos during ESC extraction.

2. **TSPSCs (Tissue Specific Progenitor Stem Cells)**

By modifying pancreatic progenitors, a kind of TSPSCs, through 3D culture,[1] researchers can create a pancreatic organoid, which contains β- cells and can be used for insulin therapy.

3. **UCSCs (Umbilical Cord Stem Cells)**

Found in the umbilical cord blood, placenta, amniotic fluid, and Wharton's jelly, pancreatic transplantation of UCSCs by intravenous injection enables treatment of diabetes through improvement in function of β cells

[1] 3D cell culture is a culture environment where cells are allowed to grow and interact with surrounding framework in three-dimensions, in contrast with traditional two-dimensional cell cultures where cells are grown in a single flat layer on a plate.

References

Mahla R. S. (2016). Stem Cells Applications in Regenerative Medicine and Disease Therapeutics. *International journal of cell biology*, *2016*, 6940283. https://doi.org/10.1155/2016/6940283

The power of stem cells. (2016, February). California Institute for Regenerative Medicine. Retrieved September 29, 2024, from https://www.cirm.ca.gov/patients/power-stem-cells/

Stem cell: 101. (2018, April 9). Institute for Stem Cell & Regenerative Medicine. Retrieved September 29, 2024, from https://iscrm.uw.edu/stem-cell-101/

Stem cells: What they are and what they do. (2024, March 23). Mayo Clinic. Retrieved September 29, 2024, from https://www.mayoclinic.org/tests-procedures/bone-marrow-transplant/in-depth/stem-cells/art-20048117#:~:text=What%20is%20stem%20cell%20therapy,stem%20cells%20or%20their%20derivatives

Type 2 Diabetes. (2023, November 8). Cleveland Clinic. Retrieved September 29, 2024, from https://my.clevelandclinic.org/health/diseases/21501-type-2-diabetes

Wu, J., Li, T., Guo, M., Ji, J., Meng, X., Fu, T., Nie, T., Wei, T., Zhou, Y., Dong, W., Zhang, M., Shi, Y., Cheng, X., & Yin, H. (2024). Treating a type 2 diabetic patient with impaired pancreatic islet function by personalized endoderm stem cell-derived islet tissue. *Cell Discovery*, *10*. https://doi.org/10.1038/s41421-024-00662-3