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Stem cell therapy for diabetes

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Diabetes mellitus (DM) is a group of metabolic diseases in which an individual has high glucose levels in the blood. It is mainly of three types, namely insulin-dependent DM (type 1), insulin-independent DM (type 2) and gestational DM (DM during pregnancy). Type 2 DM is more common than type 1 DM. Diabetes affects the entire organ system gradually, hence leading to an increased rate of morbidity and mortality. The drug categories, such as sulphonylureas, meglitinides, thiazolidinediones, metformin, dipeptidyl peptidase-4 (DPP-4) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, sodium-glucose transport protein 2 (SGLT 2) inhibitors, etc. are used for treating diabetes. Further, pluripotent stem cells are used to form definitive endoderm, which is then differentiated into pancreatic endoderm. The pancreatic endoderm further differentiates into endocrine progenitors, ultimately producing pancreatic islet cells. These insulin hormone-producing, stem cells-derived pancreatic islet cells are produced and transplanted to treat diabetes. Stem cells-derived pancreatic islets are known as pseudo-islets, which grow rapidly as proved by various researchers. Additionally, pseudo-islets can be produced using 3D organ printing, which could result in an efficient system to produce insulin in people with diabetes. Genetically engineered stem cells derived from beta cells are highly similar to endogenous beta cells with regard to their functional properties. The additional scope with stem cells is that it allows the researchers to engineer the stem cells in order to get the desired results. Owing to this property, the immune rejection response is avoided. The beta cells can be improved by employing encapsulation strategies and for this purpose, encapsulation devices have been developed. ‘Microencapsulation’ of beta cells is currently applied at the clinical level for treating diabetes. The microencapsulated beta cells treatment has been found to reduce exogenous insulin requirements. However, the drawback of this treatment is the lack of sufficient oxygen for the function of islet cells. Furthermore, ‘macroencapsulation’ of beta cells comprises a disc-shaped device that overcomes the drawbacks of microencapsulation. The microcapsule is mainly composed of two parts; the islets encapsulated in alginate gel and a gas chamber that allows daily gas filling. The microencapsulated device is implanted in the body subcutaneously. In addition, ‘microvascular’ devices with beta cells are the devices that are composed of two membranes that aim to vascularise the isolated or reaggregated islets. Therefore, these aforementioned devices have enhanced the quality of life of several diabetic patients. This may soon become a novel avenue for the treatment of diabetes.

Keywords: Diabetes, Stem cells, Macroencapsulation, Microencapsulation, Microvascular, Pseudo-islets

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