Engineered pancreatic tissues could lead to better transplants for diabetics

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Technion researchers have built pancreatic tissue with insulin-secreting cells, surrounded by a three-dimensional network of blood vessels. The engineered tissue could pave the way for improved tissue transplants to treat diabetes.

The tissue created by Professor Shulamit Levenberg of the Technion-Israel Institute of Technology and her colleagues has some significant advantages over traditional transplant material that has been harvested from healthy pancreatic tissue.

The insulin-producing cells survive longer in the engineered tissue, and produce more insulin and other essential hormones, Levenberg and colleagues said. When they transplanted the tissue into diabetic mice, the cells began functioning well enough to lower blood sugar levels in the mice.

Transplantation of islets, the pancreatic tissue that contains hormone-producing cells, is one therapy considered for people with type 1 diabetes, who produce little or no insulin because their islets are destroyed by their own immune systems. But as with many tissue and organ transplants, donors are scarce, and there is a strong possibility that the transplantation will fail.

The well-developed blood vessel network built into the engineered tissue is key to its success, the researchers concluded. The blood vessels encourage cell-to-cell communication, by secreting growth hormones and other molecules, that significantly improve the odds that transplanted tissue will survive and function normally.

The findings confirm that the blood vessel network "provides key survival signals to pancreatic, hormone-producing cells even in the absence of blood flow," Levenberg and colleagues concluded in their study published in the journal PLoS One.

One reason transplants fail, Levenberg said, "is that the islets are usually transplanted without any accompanying blood vessels." Until the islets begin to connect with a person's own vascular system, they are vulnerable to starvation.

The 3-D system developed by the Technion researchers tackled this challenge by bringing together several different cell types to form a new transplantable tissue. Using a porous plastic material as the scaffold for the new tissue, the scientists seeded the scaffold with mouse islets, tiny blood vessel cells taken from human umbilical veins, and human foreskin cells that encouraged the blood vessels to develop a tube-like structure.

"The advantages provided by this type of environment are really profound," said Xunrong Luo, an islet transplantation specialist at the Northwestern University Feinberg School of Medicine. She noted that the number of islets used to lower blood sugar levels in the mice was nearly half the number used in a typical islet transplant.

Islets grown in these rich, multicellular environments lived three times as long on average as islets grown by themselves, Levenberg and colleagues found.

The technology "is still far from tests in humans," Levenberg said, but she noted that she and her colleagues are beginning to test the 3-D tissue scaffolds using human instead of mouse islets.

According to Northwestern's Luo, the 3-D model demonstrated in the study "will have important and rapid clinical implications" if the same results can be replicated with human cells. "This model system also provides a good platform to study the details and mechanisms that underlie successful transplantation."

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