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► To cite this version:

Emily Tubbs, Clément Quintard, Amandine Pitaval, Joris Kaal, François Boizot, et al.. Vascularized pancreatic islet-on-chip for type 1 diabetes. EUROocs 2024 - EUROoCS Annual Meeting 2024, Jul 2024, Milan, Italy. hal-04399755

HAL Id: hal-04399755

<https://hal.science/hal-04399755>

Submitted on 17 Jan 2024

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Vascularized pancreatic islet-on-chip for type 1 diabetes

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Diabetes is a growing threat to global health, currently affecting 537 million people worldwide, or 1 in 10 adults. The World Health Organization predicts that 783 million people will suffer from diabetes in 2045. Diabetes, type 1 or 2, cause an abnormal and prolonged increase of the blood glucose level, mainly caused by deficiency or failure to use insulin. In the long term, diabetes can lead to many complications, including vasculopathy, neuropathy, retinopathy, and diabetic foot ulcer. There is a need to understand the mechanisms of action in a human model in order to finely-tune the treatment for each patient. Building *in vitro* analytical tools is crucial to model the complexity of physiology and pathophysiology of pancreatic islets for a better understanding of its basic biology as well as for the screening of new drugs. While most common perfusion systems require pooling of multiple islets to achieve quantifiable insulin concentrations, minimizing the number of islets required for experiments using microfluidic platforms is important given the scarcity of these biological tissues.

We have previously designed and validated a microfluidic device integrating a network of hyper-elastic valves for automated glucose stimulation and insulin collection from a single pancreatic islet [1]. Here, we used the same serpentine chip design and cultured human beta cells spheroids composed of EndoCBH5 cells (from Human Cell Design©), in a fibrin gel enriched in endothelial cells and fibroblasts. Thus, we tested the effect of flux, and of an enriched vascular microenvironment on the functionality of the human beta cells spheroids. A glucose stimulated insulin secretion assay was performed and we observed an improved functionality of the human beta cells spheroids with both the flux and the enriched microenvironment. Our results confirm that recreating a favorable pancreatic islet niche significantly improves functionality [2].

Our results pave the way to personalized medicine for the study of diabetes. The perspectives offered by this islet-on-chip model are considerable and promise to be beneficial to patients.

References

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[2] Quintard C, Tubbs E, Jonsson G, Jiao J, Wang J, Werschler N, Laporte C, Pitaval A, Bah T, Pomeranz G, Bissardon C, Kaal J, Leopoldi A, Long D, Blandin P, Achard J.-L, Battail C, Hagelkruys A, Navarro F, Fouillet Y, Penninger J, Gidrol X. *A microfluidic platform integrating functional vascularized organoids-on-chip*. Nature Communication, in press.