Creation of multi-scale vascular networks in engineered tissues

J. Rouwkema[1]
Presenting Author: J. Rouwkema j.rouwkema@utwente.nl
[1] *Dept. of Biomechanical Engineering, Technical Medical Centre, University of Twente, The Netherlands*

Optimally engineered tissues will often need to contain a vascular network; either to supply the cells in the tissue with nutrients after implantation, or to ensure a physiological tissue response when the tissue is used as a screening platform [1]. Especially when the tissue is engineered for implantation purposes, this network needs to be properly organized, including macro-vascular structures but also micro-vascular capillaries, to accommodate a functional connection with the vasculature of the patient.

Over the past years, multiple approaches have been developed to include vascular networks in engineered tissues. Under the right conditions, the addition of vascular cells within tissue constructs leads to the formation of vascular networks. However, these networks are generally randomly organized and mainly consist of microvascular structures. On the other hand, bio-fabrication approaches can be used to fabricate vascular networks with a tightly controlled and designable organization. However, resolution is often insufficient to include capillary structures and the organization can be lost over time due to tissue remodeling.

In order to achieve multiscale organized vascular networks, we are developing a 3D embedded bio-printing approach to spatially control the presence of vascular cells within tissue analogues. This can be seen as a starting situation which will remodel and mature over time. To further guide the organization of the vascular network over multiple scales, both chemical and mechanical cues are included. With this approach, our aim is to control tissue remodeling and maturation, resulting in a vascular network that resembles a vascular tree.

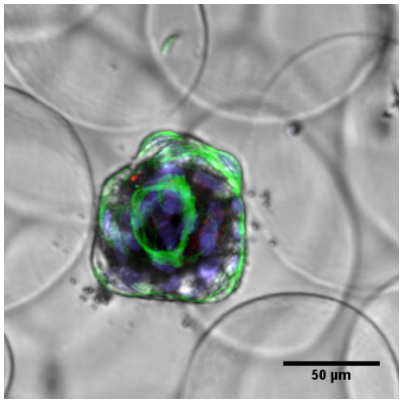

Figure 1: human mesenchymal stromal cell (MSC) – HUVEC spheroid deposited within an environment consisting of monodisperse alginate particles.

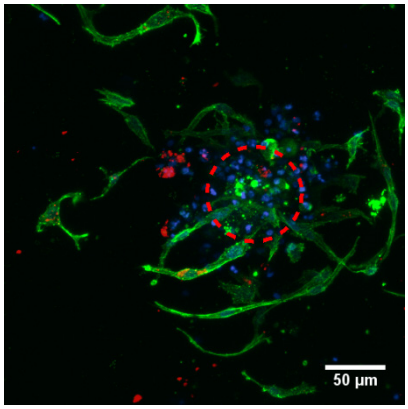

Figure 2: MSC-HUVEC spheroid after culture for 6 days in a collagen-functionalized microparticle environment. The red dotted line denotes the initial location of the MSC spheroid.

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REFERENCES

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