3D printing of microvascular capillary scale constructs

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The size of biofabricated tissue constructs are often limited by the lack of a perfusable vascular network. We sought to develop a novel approach by fabricating microvascular constructs to a capillary scale using high resolution inkjet printing.

Pluronic F127(PF127) was patterned with Electrohydrodynamic(EHD) inkjet printing onto a temporary mold with the smallest channel feature size of 20μm. Gelatin methacrylate(GelMA) was synthesized using a sequential pH adjustment method as a photo-crosslinkable hydrogel matrix. This was mixed with human dermal fibroblasts(HDFs), casted over the fugitive PF127 ink and crosslinked with UV light at 365nm. Utilising the thermoreversible properties of both inks, the construct was rapidly cooled to 4°C, liquefying the PF127 ink which facilitated removal. Channels were seeded with human vein endothelial cells(HUVECs) and patency evaluated using FITC-dextran perfusion.

Microvascular networks were created with channel diameter at 60 μm for optimal success. Tissue constructs were maintained by perfused media over 21 days in culture, exhibiting superior cell viability over unpatterned matrix controls (92% vs 13%).With 3D co-culture of HDFs and HUVECs, the perfused microchannels were covered by a confluent endothelium monolayer surrounded by support tissue consisting of fibroblasts.

We demonstrate feasibility of inkjet printing capillary sized channels which have potential for upscaling.