Development of human vascular tissue thanks to an advanced biotechnology: the bioprinting

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After many years of research in the field of engineering and regenerative medicine, an obstacle remains: the design and construction of large-scale vascularized in vitro tissues (>1 cm3) for biological studies and transplantation. As a result, demands for bioengineering methods enabling blood vessels production continue to grow and current options for vascular design remain limited. The reasons for this are the necessary advanced requirements of blood vessels such as distribution, organization, adhesion, migration, and maturation of living cells inside bioengineered constructs, but also the formation of functional extracellular matrix (ECM) and the development of a non-thrombogenic endothelium.

A vascular tissue is made of three concentric layers: the tunica intima, the media and the adventitia. These layers are respectively composed by endothelial cells (ECs), smooth muscle cells (SMCs) and fibroblasts (FBs), trapped in a highly organized extracellular matrix (ECM) composed mostly of type I collagen, type III collagen and elastin.

Here, we present 3D bioprinting techniques developed to produce human vascular tissue: the co-axial system[1,2], the FRESH method[3], the 3D bio-extrusion[4], and the 3D multi bio-extrusion[5]. Advantages and drawbacks of each method together with the characterization of the obtained tissues will be presented and discussed.

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