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Structural characterization of 3D-reconstructed artificial blood vessels

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Introduction
Creating a small-diameter blood vessel substitute is one of the goals of tissue engineering. These substitutes could be used for coronary artery bypass graft surgery. The cell-seeded polymer scaffold approach offers the ability to form tissue substitutes in vitro relatively rapidly with the properties and shape representative of native tissue. The challenge in this research area is to find the best combination of scaffold material, cells and seeding- and culture procedures. The properties of the tissue-engineered blood vessel can be influenced by mechanical and biochemical conditioning during culture.

Objective
Finding the ideal combination of shear and stretch protocols (i.e. mechanical conditioning) to influence the development of the blood vessel constructs.

Scaffolds
Different scaffold materials are used for tissue engineering applications. The desired characteristics of the scaffold material are:

- highly porous interconnected pore network
- biocompatible and bioresorbable
- suitable surface chemistry for cell attachment, proliferation and differentiation
- mechanical properties to match those of the tissues at the site of implantation
- be reproducible processed into variety of shapes and sizes

One of the most used material is non-woven Poly(glycolic acid) (PGA), which has a fiber-like structure. Because PGA is stiff and brittle and degrades in a few weeks, it is often coated. An example of such a coating is Poly(L-lactide) PLLA which increases strength and degradation time. A picture of PLLA coated PGA is shown in figure 1. Besides spraying the coating on the PGA, the scaffold can also be dipped into the coating. SEM images of PLLA-dipped PGA scaffolds are shown in figure 2.

Another, new, scaffold material is that of Radi Medical Systems (Sweden).

Cells
The scaffold material will be seeded with human cells, i.e., human coronary artery smooth muscle cells (HCASMC) and endothelial cells (HCAEC)(Clonetics). The first step is to investigate whether the cells attach and grow on the material. Figure 4 shows SEM images of HCASMCs attaching to the Radi material.

Conclusions
The Radi material seems to be an appropriate scaffold material with a highly porous structure. HCASMC grow on this new material.

Future
Seeding HCASMC on tubular constructs made of Radi material and of PGA/PLLA and trying to influence the structure of the bloodvessel by mechanical conditioning (shear, stretch).

References

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