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A scaffold for a tissue engineered heart valve

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Introduction

Tissue engineered aortic valves are made of autologous cells that were cultured on a biodegradable scaffold, to finally leave fully developed tissue that is the patient's own. However, the state-of-the-art tissue engineered valves are too weak to withstand aortic blood pressure levels.

Objectives

A tissue engineered aortic valve must be strong enough to meet physiological circumstances, so the cells must be given time to create their own strong fiber structure (fig. 1).

Figure 1. A natural valve leaflet. The load-bearing collagen fiber architecture is clearly visible

Until the cells have done so, the scaffold material needs to carry the load. Hence the scaffold must be degraded over an extended period of time, be strong at critical sites in the valve (fig. 2), but allow for cellular ingrowth at the same time.

Fibroblast culture in and on fibrin gel showed viable, widely spread cells. Polycaprolactone fibers in fibrin gel, seeded with cells, showed a coherent structure in which the cells had overgrown the pores (figs. 3a-d).

Figure 3. Fibroblast culture on a) polycaprolactone fibers (5x), b) fibrin gel (20x) and c) and d) fibers in fibrin gel (20x and 40x)

The valvular shaped scaffold (fig. 4) shows leaflets that are big enough to coapt and in the outer wall sinuses are formed, similar to those in a natural valve.

Figure 4. A knitted polycaprolactone valve, covered with fibrin

Discussion

Unlike previously produced scaffolds, this valvular scaffold does not have weak connections at the areas in the valve most prone to tear. Since this scaffold is open and strong and it induces cellular attachment, it is a promising combination of materials and scaffold design.

Future work

This scaffold will be seeded with cells and be subjected to a dynamic culture environment that mimics physiological circumstances. Cellular behavior, in particular extracellular matrix production, will be studied.

References

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