Electrospinning versus knitting: two scaffolds for tissue engineering of the aortic valve

Citation for published version (APA):
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Introduction
State-of-the-art tissue engineered aortic valves are not strong enough to withstand aortic blood pressure levels. We hypothesize that current scaffolds do not have enough mechanical integrity and that they degrade too fast.

Objectives
Design of a valvular scaffold needs to focus on strong commissures, since they are high-stress regions in a valve (Fig. 1). Scaffold material must degrade slowly, to enable the seeded cells to create their own strong matrix that eventually replaces the degrading scaffold.

Materials and Methods - scaffolds
Valvular scaffolds were fabricated by electrospinning or by knitting of polycaprolactone (Fig. 2). Strong commissures for the spun valves were realised by electrospinning a leaflet and a corresponding sinus out of one piece and for the knitted valves by knitting the leaflets to the scaffold wall.

Materials and Methods - valve culture
Human Vena Saphena (HVS) myofibroblasts were enclosed in fibrin gel and cultured on the electrospun or knitted scaffold in a bioreactor that provided continuous medium perfusion (Fig. 4).

Results - scaffolds
The electrospun scaffold tore within six hours, whereas the knitted scaffold remained intact (Fig. 5).

Results - valve culture
Because of small pores in the spun scaffold, the majority of the cells remained on top of the scaffold. In the knitted scaffold cells penetrated well, as can be seen in Fig. 6.

Discussion
The knitted scaffold has strong commissures and allows good cell penetration. The spun scaffold is not very strong, which does not have to be a problem if seeded cells make enough extracellular matrix. In that case however, the spun scaffold must be adapted to enable proper cell penetration.

References