Mechanocontrol of cardiovascular tissue properties

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Introduction
In cardiovascular tissue engineering living autologous grafts are cultured in vitro to ultimately overcome the drawbacks of currently used treatments. Tissue engineering (TE) of load bearing tissues has been relatively successful [1]. However, the mechanical properties of these tissues are insufficient for placement at high pressure positions. Collagen architecture (content and organization, fig. 1) is primarily responsible for the mechanical properties of these tissues and is closely related to the mechanical loading condition within the tissue. Improvement of the mechanical properties requires a detailed study of mechanically induced collagen remodeling.

Objective
By applying well defined loading protocols quantitative information on mechanically induced collagen remodeling can be obtained. Studying the collagen architecture and mechanical properties of tissue engineered constructs simultaneously, will enable us to control tissue properties and improve tissue engineering culture conditions.

Materials and Methods
Tissue engineered constructs, consisting of cells seeded in a PGA/P4HB coated scaffold, were cultured for 4 weeks (1 week unstrained and 3 weeks strained) at different strain levels using a flexercell straining system (fig. 2). The mechanical properties of these constructs were tested (n = 5) and collagen organization was visualized.

Results
Mechanical straining showed to have an effect on the mechanical properties of the engineered constructs (fig. 3A). Improved mechanical properties were observed for constructs subjected to higher amounts of strain, whereas collagen content within these constructs (data not shown) did not show any difference.

Discussion
Mechanical loading showed to have an effect on the mechanical properties and collagen orientation of the tissue engineered constructs, whereas no effect on collagen content was observed. Therefore, differences in mechanical properties can be mainly attributed to different degrees of collagen alignment within the constructs.

Future work
- Quantify collagen architecture (orientation).
- Quantify the effect of mechanical loading on collagen alignment as a function of time and strain.

References: