Mechanical characterization of coronary arteries in an ex vivo culture model

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Introduction
Knowledge of mechanical properties of living arteries is important to understand vascular function in healthy and diseased arteries. The mechanical behaviour of the artery can, among other things, be related to the extent of smooth muscle activity and its morphology. An effective way to study the behaviour of living tissue is organ culture.

We have developed an ex-vivo model in which a coronary artery can be cultured under physiological circumstances: coronary pressure and flow, cyclic longitudinal elongation of the artery and physiological wall shear stresses are controlled. In the model, mechanical behaviour is determined by dynamic measurement of pressure, internal diameter and axial force simultaneously.

Methods
A segment of a porcine coronary artery, about 4 cm of in vivo length, is put in an organ bath and immersed in and perfused with culture medium, providing the necessary nutrients to the artery. The set-up is placed in an incubator ensuring a physiological environment, regarding temperature, oxygen and humidity. An extension device induces axial cyclic elongation of the segment, typical for the coronary artery. Coronary pressure and flow are simulated with a pump based on a model of the coronary circulation developed by Geven (2004). Physiological wall shear stresses are important for maintenance of endothelial cell integrity. Therefore, the viscosity of the culture medium should be increased to blood viscosity levels.

Results
The complete ex vivo model consists of 4 units in parallel, one of which is schematically represented in figure 1(a). The coronary segment is perfused with a physiological pressure and flow. Moreover, the, typical for coronaries, inverse relationship of pressure and flow is simulated as well (figure 1 (b)). Gijsen (1999) used xanthan gum (XG) to create a non-Newtonian solution with increased viscosity. A study at our lab showed XG to be suitable in arterial culture as well, as there was no negative effect of XG on medium osmolality or arterial activity upon addition of vaso-active drugs. Therefore, XG was used to increase medium viscosity to create physiological wall shear stresses.

The artery's inner diameter is measured using an ultrasound system (ART.LAB, Pie Medical). Pressure and axial force are measured with a pressure and force transducer, respectively.

Conclusions
The current model is competent in creating a physiological environment for the coronary artery, which is needed in arterial culture. Moreover, arterial mechanical behaviour can be studied during culturing.

References