Introduction

In view of the shortage of donor hearts, continuous flow left ventricular assist devices (cf-LVADs, Figure 1A) have become an effective therapeutic option as mechanical circulatory support system to bridge heart failure patients to cardiac transplantation. In a limited number of cases, these devices may induce myocardial remodeling and functional recovery of the ventricle, which might make an additional heart transplantation superfluous. In these patients, after explantation of the pump, the patient’s own heart may resume its function again.

Objective

In this study we use a mathematical model (Figure 1B) of the assisted heart and circulation to characterize the effect of myocardial tissue properties of patients supported by cf-LVADs, on global hemodynamic parameters, based on clinically measured data.

Methods

The mathematical model explicitly relates mechanical myocardial tissue properties such as stiffness and contractile behaviour to global parameters of the circulation (Figure 2). The model is applied to simulate clinical parameters during a pump speed change procedure (PSCP), in which the relation between cardiac- and pump function is measured. Furthermore, clinical data including the non-invasive blood pressure waveform, ventricular geometry and aortic valve dynamics are considered to perform model-based estimation of myocardial tissue properties of the individual patient.

Results

The model simulates the effect of mechanical myocardial tissue stiffness and contractility indexes with left ventricular pressure, wall volume and cavity volume among others.

Conclusion

The model simulates the effect of mechanical myocardial tissue properties on clinical parameters during a PSCP with a cf-LVAD. Parameter estimation algorithms are to be built to characterize these properties for an individual patient.