MODEL-BASED DISAGNOSIS OF ACUTE PULMONARY EMBOLISM – RESULTS FROM A PORCINE MODEL

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Introduction

Accurate computational models in conjunction with clinical data can be used to create patient-specific models that match the clinical measurements. If these models are physiological, then the patient-specific parameters, or changes in them over time, can be used to diagnose disease states, the affect of drug therapy, or the acute onset of dysfunction. This model-based diagnostic approach is applied with an existing minimal computational model to a porcine simulate of acute pulmonary embolism.

Methods

The model consists of 6 elastic chambers including the right and left ventricles, as well as the pulmonary and systemic circulation systems. It accounts for ventricular interaction and valve dynamics. Under the control of the Ethics committee of the Medical Faculty of the University of Liege, pulmonary embolization was made in (N=6) healthy pigs with autologous blood clots to provide the clinical data. Right ventricular pressure-volume loops were recorded using a conductance catheter while end-systolic ventricular elastance was periodically assessed by varying right ventricular preload.

Results

Errors between the identified model and clinical data are within 10% in all cases. Pulmonary resistance increased significantly with the onset of embolism in all cases, as expected, ranging from 89.98% to 261.44% of the initial state (Fig 1a). The model also predicted increases in right ventricle expansion index of ~33% (Fig 1b), and a decrease in septum volume. Each is consistent with known physiological response.

Conclusions

A minimal closed-loop model of the cardiovascular system is able to detect, and thus monitor and diagnose the onset of acute pulmonary embolism. These results are a first clinical result in this arena and illustrate the potential of model-based monitoring and diagnostic systems to create a single, clear physiological picture from a series of individual clinical measurements.

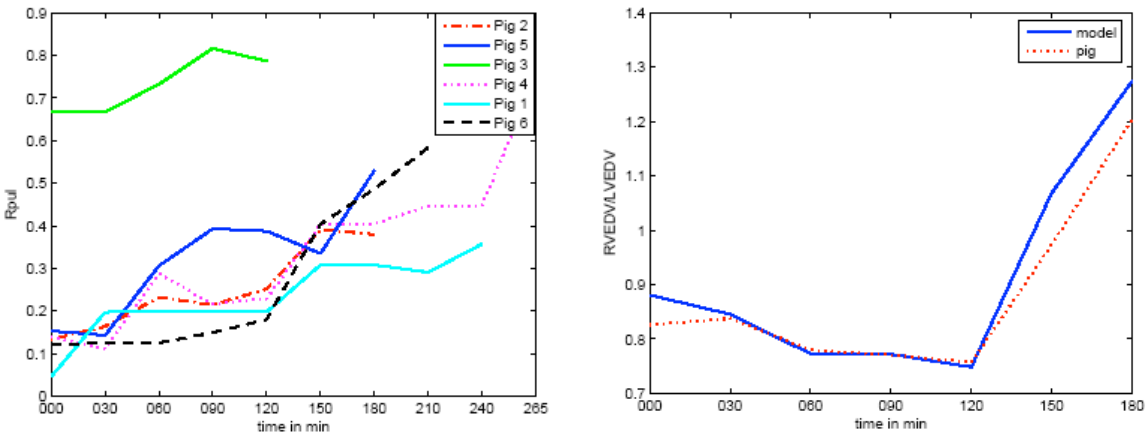

Figure 1 : a) Pulmonary resistance for all 6 pigs over experiment time ; b) Right ventricle expansion index (RVEDV/LVEDV) for Pig 2.