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► **To cite this version:**

K. R. Owashi, A. Hubert, Elena Galli, Erwan Donal, A. Hernandez, et al.. Non-invasive estimation of myocardial work in aortic stenosis from modelling approach. *European Heart Journal*, 2020, 41 (Supplement\_2), pp.51-51. 10.1093/ehjci/ehaa946.0051 . hal-03155845

**HAL Id: hal-03155845**

**<https://hal.science/hal-03155845>**

Submitted on 11 Mar 2021

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# Non-invasive estimation of Myocardial Work in Aortic Stenosis from Modelling Approach

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**Background:** The noninvasive assessment of myocardial work by pressure-strain loops (PSL) analysis is a recently introduced tool to estimate myocardial performance. PSL analysis cannot be applied to patients having an obstacle to LV ejection, as in the case of aortic stenosis (AS), because of the difficulty to estimate left ventricular (LV) pressure. The objective of this work is to propose a non-invasive model-based estimation of the left ventricular pressure curve in AS patients in order to evaluate myocardial work indices.

**Methods:** Twelve patients with moderate-to-severe AS underwent cardiac catheterization to acquire the LV pressure ( $P_{lv}^{exp}$ ). All patients underwent a standard trans-thoracic echocardiography to extract regional myocardial strain curves and estimate the aortic valve area (AVA). Systolic and diastolic arterial pressures were also measured. The proposed cardiovascular system (CVS) model is composed of four main coupled sub-models simulating: *i*) cardiac electrical activities, *ii*) mechanical cardiac cavity, *iii*) the systemic and pulmonary circulation, and *iv*) cardiac valves (Figure 1). A 2-step parameter identification strategy, based evolutionary algorithms, was implemented to learn LV parameters from  $P_{lv}^{exp}$  and to estimate patient-specific model-based LV pressure curves ( $P_{lv}^{model}$ ) starting from parameters obtained from non-invasive hemodynamics. Global myocardial constructive work (GCW) and myocardial wasted work (GWW) were calculated using  $P_{lv}^{exp}$  and  $P_{lv}^{model}$ .

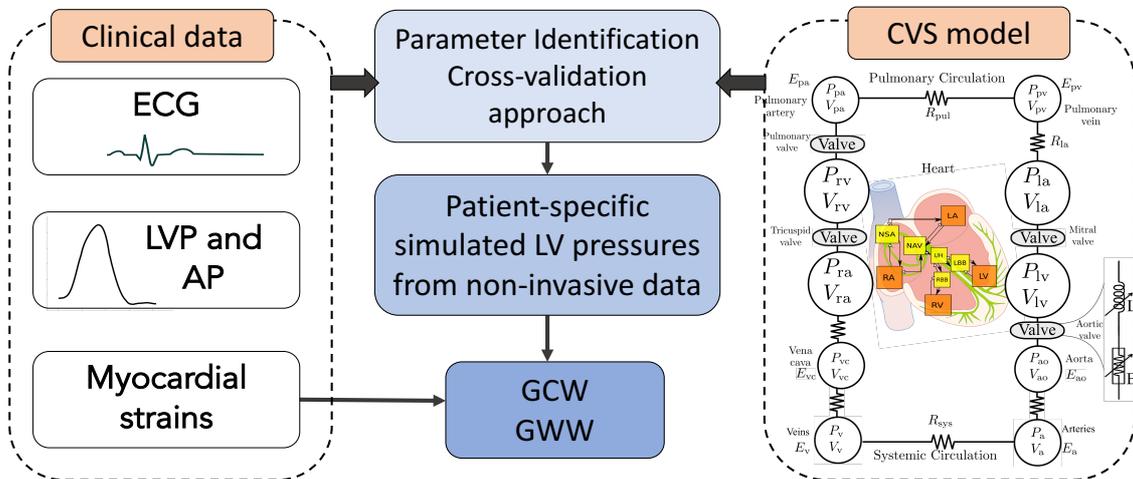


Figure 1: Clinical Dataset (left). Parameter identification strategy (middle). CVS model (right).

**Results:** A close match was observed between  $P_{lv}^{exp}$  and  $P_{lv}^{model}$ , with a mean total relative error of 12.27% (range 5.9% to 17.40%). When considering GCW and GWW, global correlation was equal to 0.92 ( $p < 0.0001$ ). In BA analysis, mean bias was -2.9 mmHg.%, which corresponds to relative bias equal to 0.11% with respect to mean value of work indices (Figure 2).

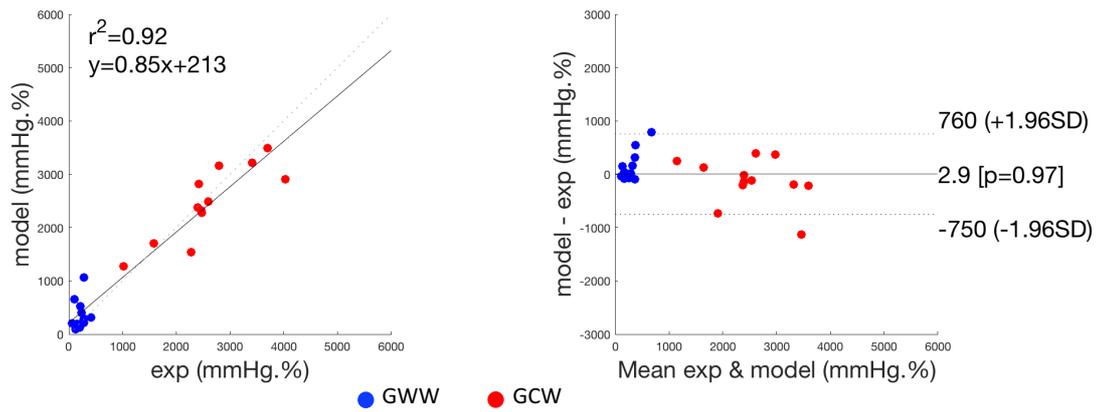


Figure 2: Work indices comparison for the 12 patients. Scatter and BA plots for GWW (blue) and GCW (red).

**Conclusions:** A model-based approach can be used to estimate LV pressure and myocardial work indices in patients with AS, and be provide a promising tool for the assessment of myocardial performance in patients with AS.