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5 May, 2015

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Re: Chung et al. Letter to the Editor in response to: Early detection of abnormal left ventricular relaxation in acute myocardial ischemia with a quadratic model. Med Eng Phys. 2014 Sep;36(9):1101-5. Morimont et al.

Dear Dr Black,

We are grateful for the comments to our recent manuscript [1] provided by Chung, Shmuylovich and Kovács and we very much appreciate their effort in further elucidating left ventricular (LV) relaxation [2]. We are happy to respond to their comments as follows.

We fully agree with them that models based on known physiologic attributes of isovolumic relaxation (IVR) and their physical/physiologic analogs provide a clearer view and consistent model of IVR. LV relaxation is a complex mechanism that is governed by the continuous interplay of the sensitivity of the contractile system to the loading conditions and the dissipating activation [3]. This double control is modulated by the regional and temporal non-uniform distribution of loading condition and activation front [4].

While mechanical non-uniformity during IVR was documented in several pathological conditions like acute LV ischemia [5], the classical method uses a monoexponential fit of IVR. Thereby, this conventional method can fail to accurately detect abnormalities in the relaxation process in some cases. The aim of our study was to provide a clinically applicable, and thus relatively simple, method that could detect abnormalities in LV relaxation, eventually in real-time at the bedside, by using a non-uniform function, to improve diagnosis and/or treatment of acute LV ischemia.

Our "quadratic" model is based on a time constant and a degree of "non-uniformity" of LV relaxation. Our model, derived from the logistic model[6], was very sensitive to detect changes in relaxation resulting from ischemia. It was not possible to determine to what extent physiologic attributes like elastic recoil and/or viscous cross-bridge relaxation were implied. Chung, Shmuylovich and Kovács[2] propose that a best model should be derived from physical/physiological considerations, while we believe a best model must first be able to detect changes in relaxation with as much sensitivity as possible. The tension between these perspectives, and the use of model-based approaches to medicine, includes all the potential difficulties of (real-time) identification of model parameters, where their model has significant potential to be practically unidentifiable when the relationship is linear or nearly linear, as well as other cases that do not fit the assumed model profile [7]. As a result, the model of Chung, Shmuylovich and Kovács should be tested during LV ischemia to determine its sensitivity to detect changes in LV relaxation and its identifiability across cases. The advantage of their model would be to elaborate on effects of ischemia on elastic recoil and/or viscous cross-bridge relaxation.

Sincerely,

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Signed,

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