Myocardial work index better reflects contractility than longitudinal strain in rat models of pressure- and volume overload-induced heart failure

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Speckle-tracking echocardiography (STE)-derived global longitudinal strain (GLS) is considered to be a sensitive marker of left ventricular (LV) function in a wide variety of cardiovascular diseases. Still, evidence suggests that GLS is significantly influenced by loading conditions. Myocardial work index (MWI) evaluates myocardial deformation in the context of afterload through the interpretation of strain in relation to instantaneous LV pressure. MWI may potentially overcome the limitations of mere strain calculation, and may better reflect cardiac contractility in hemodynamic overload states.

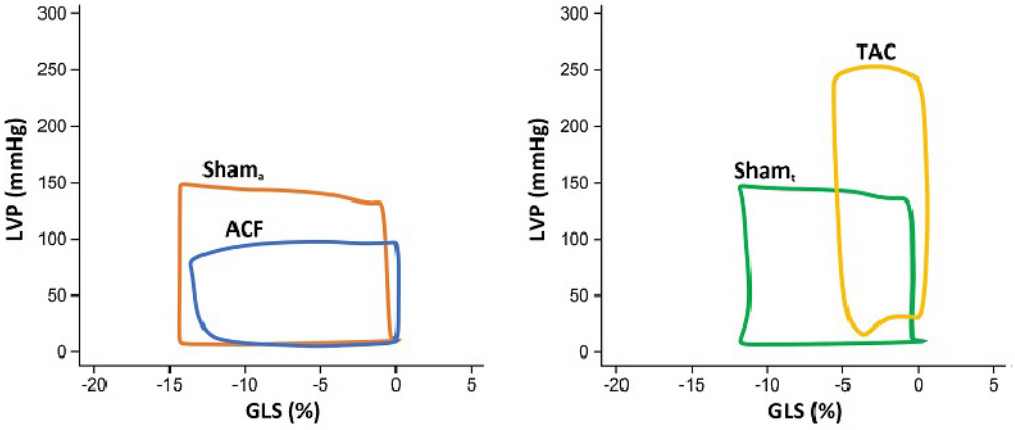
Accordingly, our aim was to examine the relationship of GLS and MWI with load-independent markers of LV contractility in rat models of pressure- and volume overload-induced heart failure.

Male Wistar rats underwent transverse aortic constriction (TAC; n = 12) to generate LV pressure overload, or aortocaval fistula (ACF; n = 12) was established to induce severe LV volume overload. In case of the control groups, sham procedures were performed (n = 12/12). Echocardiography loops were obtained to determine STE-derived GLS and global MWI. Pressure-volume analysis with transient occlusion of the inferior vena cava was carried out to calculate preload recruitable stroke work (PRSW), as a load-independent „gold-standard" parameter of LV contractility.

GLS was mildly reduced in the ACF group (-13.2 ± 2.4 vs. -15.4 ± 2.0%, p < 0.05), while it was significantly lower in TAC group compared to controls (-7.0 ± 2.8 vs. -14.5 ± 2.5%; p < 0.001). In contrast with these findings, PRSW and also MWI were significantly reduced in ACF (58 ± 14 vs. 111 ± 40 mmHg; 1328 ± 411 vs. 1934 ± 308 mmHg%, both p < 0.01), however, they were comparable between TAC and the corresponding sham group (110 ± 26 vs. 116 ± 68 mmHg; 1687 ± 275 Hgmm% vs. 1537 ± 662 Hgmm%; both p = NS). In the pooled population, GLS did not show relationship with PRSW (r=-0.23; p = 0.12), while MWI showed significant correlation with it (r = 0.70; p < 0.001).

GLS is significantly influenced by loading conditions, therefore, in case of severe pressure- or volume overload it may not be a reliable marker of LV contractility. In our rat model of pressure overload induced heart failure, contractility was maintained despite decreased GLS, while in the model of volume overload induced heart failure, GLS was maintained despite decreased contractility. MWI reflects contractility in hemodynamic overload states, therefore, it may be a more suitable marker of systolic function.

Abstract Figure. Pressure-strain loops of the groups



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