Quantification of left and right atrial kinetic energy using four-dimensional intracardiac magnetic resonance imaging flow measurements

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Background
Kinetic energy (KE) of atrial blood has been postulated as a possible contributor to ventricular filling. Furthermore, KE is independent of blood pressure and may thus be altered in disease with normal blood pressure. Atrial blood KE, however, has not previously been measured over the whole cardiac cycle, and thus its contribution to cardiac function remains unknown. We therefore aimed to quantify the left and right atrial blood KE using cardiac magnetic resonance (CMR), and to identify mechanisms contributing to atrial KE.

Methods
Nine healthy volunteers underwent CMR, including a four-dimensional phase contrast flow sequence using a 3T MRI scanner. Atrial anatomy was manually delineated...
and KE within these delineations was calculated as \( KE = \frac{(m*v^2)}{2} \).

**Results**

Mean left atrial (LA) KE was 1.1±0.1 mJ (mean±SEM), and mean right atrial (RA) KE was 1.7±0.2 mJ (P<0.01). Three KE peaks were seen in both atria; one in systole, one during early diastole, and one during atrial contraction. The systolic LA peak was significantly smaller than the RA peak (P<0.01). Early and late diastolic peaks did not differ, however the increase of early diastolic KE from end-systolic KE was much higher in the LA (P<0.01). There was a high correlation between mean systolic KE and the combination of atrial volume and systolic velocity of the atrioventricular plane displacement (\( R^2=0.84 \) for LA and \( R^2=0.93 \) for RA). The diastolic KE of the LA correlated with LV mass (\( R^2=0.44 \)), however no such correlation was found in the right heart. Atrial KE did not correlate with body surface area.

**Conclusions**

Our findings suggest that LA KE increases during early diastole due to LV elastic recoil, indicating that LV filling is dependent on diastolic suction. RV relaxation does not seem to contribute to atrial KE. Instead, atrial KE generated during ventricular systole may contribute to RV filling during early diastole.

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