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Dissipative Energy Loss within the Left Ventricle Detected by Vector Flow Mapping in Children: Normal Values and Effects of Age, Heart Rate, and Preload

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Introduction:
The intraventricular blood flow pattern can reflect an alteration in the left ventricular (LV) function. Vector flow mapping is a novel echocardiographic technique that enables visualization of the intraventricular flow velocity vector using color Doppler cineloop images. Dissipative energy loss (EL), derived from the velocity vector field, is a flow dynamic parameter that quantifies spatial dispersion of the intraventricular blood flow. In the present study, we aimed to establish the reference value of EL within the LV in healthy children.

Methods:
We reviewed the echocardiographic data of 48 children (29 males) with structurally normal hearts. Apical 5-chamber view images were used to obtain the velocity vector fields of intra-LV blood flow during 1 cardiac cycle, and the EL values during systole and diastole were estimated. The measurements were averaged over 3 cardiac cycles, and indexed to body surface area (BSA).

Results:
The mean subject age was 7.1 ± 4.1 years and mean heart rate (HR) was 92 ± 17 beats/min. The mean EL was 3.30 ± 1.62 mW/m/m^2 BSA during systole and 13.65 ± 7.96 mW/m/m^2 BSA during diastole. On multivariate analysis, age and HR were independent predictors of systolic EL, whereas age, HR, and E wave peak velocity were independent predictors of diastolic EL. The regression equations used to predict systolic EL and diastolic EL were as follows:
$\log_{10}$ (systolic EL) = – 0.277 – 0.00142 × age (months) + 0.00927 × HR (beats/min) (adjusted R^2 0.781; $p < 0.0001$)
$\log_{10}$ (diastolic EL) = 0.317 – 0.00299 × age (months) + 0.00603 × HR (beats/min) + 0.00427 × E wave peak velocity (cm/s) (adjusted R^2 0.793; $p < 0.0001$)

Conclusions:
Systolic and diastolic EL were positively correlated with HR and negatively correlated with age. Moreover, diastolic EL was positively correlated with E wave peak velocity. Although the clinical implications of EL within the LV in the assessment of cardiac function are currently unclear, the present study provides reference values for systolic and diastolic EL that can be used by future studies examining patients with various heart diseases.