Myocardial trabeculae improve left ventricular function: a combined UK Biobank and computational analysis

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The ventricular endocardium is lined by a highly-conserved, fenestrated network of muscular trabeculae [1]. Their physiological significance is unclear and it is debated whether abnormal formation of myocardial trabeculae represents a distinct cardiomyopathy, a common phenotypic expression of several genetic cardiomyopathies, or an isolated morphological trait [2,3].

We investigated whether left ventricular (LV) trabecular morphology contributes to ventricular function using a machine-learning analysis of cardiac imaging data. We then applied these findings to a finite-element model of the left ventricle to determine the effect of trabeculae on ventricular mechanics.

**Methods:** Left ventricular trabeculae were characterised using cardiac magnetic resonance imaging in 6791 participants from the first 10,000 people imaged for the UK Biobank Imaging Enhancement (access agreement no. 18545). Ventricular volume, mass and fractal dimension, as a marker of trabecular complexity, were analysed by machine learning and correlated with cardiovascular and anthropometric data by scaled linear regression. Using a separate finite-element computational LV model, the haemodynamic effects of trabecular complexity were examined under conditions of constant preload, afterload and contractility. Myocardial and trabecular mass, shape and fibre orientation were designed to emulate normal physiology with material properties optimized to fit physiologic pressure-volume relationships. The muscular contraction was simulated by increasing the material stiffness according to the contraction curve of a cardiac fibre secondary to an intracellular calcium variation.

**Results:** Fractal dimension was positively associated with indexed stroke volume (β=+0.25), cardiac output (β=+0.15), end-diastolic (β=+0.31) and end-systolic (β=+0.20) volumes and mean arterial pressure (β=+0.09) in vivo (n=6791, all p<0.001) and with similar results seen in computational modelling (Figure 1). Fractal dimension was negatively associated with heart rate (β=-0.11) and indexed systemic vascular resistance (β=-0.06, both p<0.001) in vivo.

**Discussion:** Myocardial trabeculae have significant clinical effects on LV function by increasing ventricular compliance and cardiac output and a reduction in heart rate and systemic vascular resistance in vivo. These findings suggest that far from being a vestigial feature of cardiac development, trabeculae play an active and adaptive role in modifying ventricular function.