A Predictive Model for Cardiomyopathy Progression in a Longitudinal Cohort of DMD Patients

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Background: Cardiomyopathy (CM) is currently the leading cause of mortality in patients with Duchenne muscular dystrophy (DMD). DMD CM is asymptomatic during the early stages of disease and age of onset and clinical progression vary. We previously showed that 4D kinematic analysis of cardiovascular magnetic resonance (CMR) imaging is a robust method to visualize strain and function changes in DMD patients. Our objective, using 4D CMR image analysis, is to build a predictive model to quantify disease progression, and predict functional decline as measured by left ventricular ejection fraction (LVEF) in a longitudinal cohort of DMD patients.

Methods: We obtained 4D CMR images from 40 DMD patients imaged every 12 months for three years. Localized surface area strain (Ea) values were derived from compiled 4D CMR images. Patient demographics, presence or absence (+/-) of late gadolinium enhancement (LGE) and LVEF were obtained by a trained cardiologist. Principal component analysis was used to identify prominent variables contributing most to variability. These variables, along with clinically relevant variables, were selected to build the predictive model. We built a linear mixed effects model using visit, age, basal E_a, and LGE presence. Each patient was considered a random effect to account for variability in initial CM severity.

Results: Study patients were grouped into stages of heart failure according to the American Heart Association: Stage A, LVEF>55%, LGE(-); Stage B, LVEF>55%, LGE(+); Stage C, 40%<LVEF<55%, LGE(+); Stage D, LVEF<40%, LGE(+). Linear mixed effects model showed a good prediction of LVEF on year 3 with a root mean squared error of 3.6% and an R^2 value of 0.75 (p<0.0001.).

Conclusion: Early detection is crucial for appropriate clinical intervention. This novel predictive model was developed to determine if Ea derived from 4D imaging, LVEF, and (+/-) LGE can be used to predict functional outcomes in DMD CM.