A NOVEL, SEMI-AUTOMATED TOOL TO CALCULATE SURFACE RATIOS HELPS CAPTURE CLINICALLY HIGH-RISK PATIENTS WITH LEFT VENTRICULAR NON-COMPACTION MISIDENTIFIED BY STANDARD IMAGING MODALITIES

Hanna J Tadros[1], Tam T Doan[2], Amol S Pednakar[3], Prakash M Masand[2], Joseph A Spinner[2], Tobias R Sclingmann[2], Cory V Noel[4], James C Wilkinson[2]

[1] Baylor College of Medicine, Department of Pediatrics, Cardiology

[2] Baylor College of Medicine/Texas Children's Hospital, Pediatrics, Section of Cardiology

[3] Cincinnati Children's Hospital Medical Center, Pediatrics, Section of Radiology

[4] Seattle Children's Hospital, Pediatrics, Section of Cardiology

Keywords: left ventricular non-compaction cardiomyopathy, cardiac magnetic resonance imaging, prognosis, pediatrics

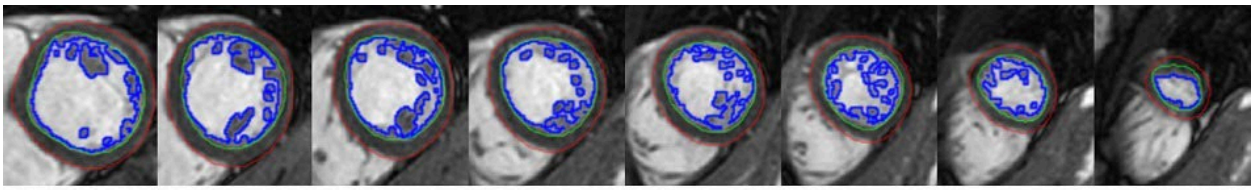
Background: Diagnostic criteria for left ventricular non-compaction cardiomyopathy (LVNC) is inadequate in determining prognosis and does not quantify non-compaction (NC) accurately. We set out to design a reliable, semi-automated, and quantitative imaging tool using cardiac magnetic resonance (CMR) imaging that captures LV trabeculations in relation to the morphologic endocardial and epicardial surface, or perimeter based ratios, more accurately and globally than presently described modalities.

Materials/Methods: We queried the echocardiogram and CMR database at Texas Children's Hospital between January 2008 and December 2018. Blinded readers (TS and CV)measured thickness of NC and compacted (C) myocardium to determine maximum NC/C ratio (NC/C) by CMR. JCW and TD applied our novel, semi-automated methodto calculate fractal dimension (FD), total mass ratio (TMR), and epicardial (SRepi), endocardial (SRendo), and composite surface ratios (SRcomp; Figure), via a post-processing tool developed in MATLAB (The MathWorks™ Inc., Natick, Massachusetts, USA). Univariate hazard ratios with cut-offs were performed using significant clinical variables and patients were categorized as "low-risk" and "high risk" for future poor outcomes. Imaging parameters were compared in "high-risk" patients misidentified by Peterson Index (PI; NC/C<2.3 or non-LVNC).

Results: In total, 96 patients were included. Mean NC/C ratio was 1.90 (SEM 0.08), mean TMR 24.40 (SEM 0.46), mean SRendo 1.68 (SEM 0.02), mean SRepi 0.99 (SEM 0.01), mean SRcomp1.95 (SEM 0.03), and mean FD 1.43 (SEM 0.01). The average time to complete our semi-automated measurements was 3.90 minutes (SEM: 0.06). TMR, SRcomp, SRepi, SRendo, and NC/C were negatively correlated with LV ejection fraction (LVEF) and positively correlated with indexed LV end-systolic volumes (iLVESV), with TMR showing the strongest correlation with LVEF (-0.287; P=0.005) and SRcompwith iLVESV (0.260; P=0.005). We found 29 "high-risk" patients who were classified as non-LVNC by PI and hence, were misidentified. This group had a mean NC/C ratio of 1.56 (SEM 0.07). When compared to non-LVNC and "low-risk" patients, SRcomp was the only imaging modality that differentiated between both groups (1.91 SEM 0.03 vs 1.80 SEM 0.03; P=0.019).

Conclusions: Coupled with strong correlations with LVEF and LV volumes, the novel tool and method of semi-automatic calculation of SRcomp captured changes in high-risk patients misidentified by standard methods (NC/C ratio) and may better capture outcome events.

Images / Graph / Table



$$\text{Surface Ratio (SR)} = \frac{\text{Cumulative length of the embedded edges}}{\text{Cumulative perimeter of the compact round shape}}$$

SR_{endo} = Trabeculation / Endo

SR_{epi} = Trabeculation / Epi

$SR_{comp} = \sqrt{SRend_o^2 + SR_{epi}^2}$