Role of Cardiac MRI and Phase Analysis Gated SPECT in Evaluation of Left Ventricular Dyssynchrony And Scar Burden in Determining the Outcome of Cardiac Resynchronization Therapy

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BACKGROUND: Cardiac resynchronization therapy (CRT) proved to improve mechanical dyssynchrony in chronic heart failure. Gated SPECT phase analysis offer objective analysis of mechanical dyssynchrony. Also scar burden assessment plays an important role in predicting response to CRT implantation, which could be performed by Gated SPECT and cardiac magnetic resonance (CMR)

AIM OF WORK: Assessment of Gated SPECT LV phase analysis before and after CRT implantation with the potential role of LV phase analysis Gated SPECT to predict CRT outcome. Quantification of LV scar burden by Gated SPECT versus CMR, and its role in predicting CRT outcome.

PATIENTS AND METHODS: Thirty patients underwent CRT implantation. Pre-implantation delayed hyperenhancement cardiac magnetic resonance was done to document scar burden and lateral wall involvement on a standard 17-segment model. Also 99mTc-MIBI gated SPECT and echocardiographic examination were done pre-implantation and 6 months after CRT implantation to assess LV volumes, and LVEF. Degree of dyssynchrony was assessed through phase analysis measurements; Histogram bandwidth BW, Standard deviation SD and entropy. The extent of rest perfusion defects on gated SPECT were assessed on a standard 20-segment model.

RESULTS: Thirty patients received CRT (mean age 58.7±9.0, 24 males). CRT implantation had a favorable prognosis on cardiac functions (LVEF pre-implantation: 30±5% versus 37±7% post-implantation; P=0.017). Echocardiographic response, defined as relative increase in LVEF by ≥15% and/or relative decrease in LVES i.e. LV remodeling by ≥15%, was documented in 19 patients (63.3%). Non-responders showed higher degrees of histogram bandwidth, histogram SD and entropy pre-implantation. Dyssynchrony parameters for responders were significant pre-implantation versus post-implantation; BW 150.7±24.8 vs 124.1±20.8; P<0.001, SD 53.8±9.1 vs 38.5±6.0; P<0.001, entropy 52.3±17.8 vs 51.0±17.1; P=0.001. Dyssynchrony parameters for non-responders; BW 174.1±32.2 vs 189.5±40.7; P=0.079, SD 61.9±10.0 vs 55.9±11.4; P=0.047, entropy 50.6±9.7 vs 51.1±9.7; P=0.016. Patients with higher LV volumes tended to show higher degrees of dyssynchrony. Phase analysis parameters were also correlated to LV remodeling; Histogram BW(R value 0.698, P value <0.001). Histogram SD: (R value 0.657, P value <0.001). However, when adjusting for CMR scar burden, neither Histogram BW nor SD was correlated to LV remodeling. Cardiac magnetic resonance was superior to gated SPECT in detection of global scar burden (34.3±11.2% vs 23.8±8.5%; P< 0.001). Also, CMR was superior to gated SPECT in detection of lateral wall scar burden (10.7±5.8% vs 4.5±4.2%; P< 0.001). Cardiac magnetic resonance examination revealed significant differences between responders and non-responders for their scar burden analysis including number of scarred segments, their global scar burden and their lateral wall scar burden. Non-responders had higher prevalence of segments with ≥50% transmural scar, (4±1.6 for responders versus 5.2±1.0 for non-responders, P value .032). Lateral wall involvement also had an impact on LV remodeling, (-15.0±0.0% for those without lateral wall involvement versus -4.3±15.4% for those with lateral wall involvement, P value .001). Applying ROC curve for CMR examination data for LV scar analysis showed that a cutoff value of 38.5% for scar burden had a sensitivity of 72.7% and specificity of 68.4% (AUC 78%, P value 0.012). Also a cutoff value of 26.5% for percentage of segments with >50% scar thickness yielded a sensitivity of 81.8% and specificity of 63.2% for prediction of non- response to CRT (AUC 74.2%, P value 0.030). A cutoff value of 43.5% for lateral wall scar burden (percentage of lateral wall), had a sensitivity of 72.7% and specificity of 68.4% (AUC 73.7%, P value 0.033).Also applying ROC curve for Gated SPECT examination data for LV scar analysis did not provide significant cutoffs for predicting CRT outcome.

CONCLUSIONS: Global and lateral scar burden of the left ventricle have unfavorable impact on CRT outcome. CMR is superior to gated SPECT in detection of scar burden and providing acceptable predictors for potential CRT non-responders. Mechanical dyssynchrony depends largely on underlying LV scar substrate and presence of mechanical dyssynchrony could not predict CRT outcome solely.

Key words: Cardiac resynchronization therapy; cardiac magnetic resonance; Gated SPECT LV phase analysis