

Late Gadolinium Enhancement in Apparently Unenhanced Myocardium in Dilated Cardiomyopathy; Evaluation using Myocardium to Lumen Ratio

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BACKGROUND

Late gadolinium enhancement (LGE) shows irreversible myocardial injury in myocardial infarction. However, current assessment of LGE based on relative signal intensity has limitation because the inversion time (TI) is adjusted to null point of remote myocardium that is considered to be normal. In infiltrative cardiac diseases such as dilated cardiomyopathy (DCM), on the contrary, apparently non-enhanced myocardium may not be normal because of diffuse involvement of the myocardium by abnormal tissue. We quantified myocardial signals as relative value to nearby lumen signals in the left ventricle (myocardium-to-lumen signal ratio; M/L) to detect abnormality of apparently non-enhanced myocardium. The purpose of this study was to determine variability of normal M/L depending upon time after contrast injection and subject conditions such as heart rate and renal function, and to detect abnormality in the left ventricular wall without apparent LGE in DCM patients.

METHODS

We have performed cardiac MRI by 1.5T system (Magnetom Sonata) using a standard protocol. LGE was evaluated with segmented IR-true FISP (ECG triggered, TI=300msec, data acquisition at late diastolic phase) at 2, 5, 10, 20 minutes after administration of 0.15mmol/kg of Gadolinium-DTPA. Seven short axis and 3 long axial sections were obtained in a single breath-hold at each time-point. We reviewed LGE images of normal myocardium (normal M/L) from 31 patients (16 men, mean age of 52.8 yrs; range 14-77, 13 with single vessel myocardial ischemia, 17 with conduction abnormality, 1 left atrial myxoma). We set 12 regions of interest (ROIs) on the myocardium (4 segments in each of vertical long axial plane, basal short axial plane, and mid ventricular short axial plane), and on blood pool in the left ventricular lumen close to myocardium of each segment, and then M/L was calculated. In patients with myocardial ischemia, ROI in the remote region was selected for analysis. We evaluated the variability of normal M/L at each time-point after contrast injection, and the correlation of M/L with heart rate (HR), hematocrit (Ht) and estimated glomerular filtration rate (eGFR). The laboratory data were obtained within one month of cardiac MR.

We also reviewed LGE images of 16 DCM patients (15 male, mean age of 55.8 yrs; range 35-90). We set ROIs on the myocardium without apparent LGE, and calculated M/L. Then we compared M/L between normal myocardium group and DCM patients by using unpaired t-test.

RESULTS

Normal M/L was measured in a total of 1080 times in 270 regions from 31 patients, from which 930 M/L data were used for analysis after excluding 150 regions with low SNR. M/L averaged at each time point in each patient is plotted in figure 1. Normal M/L was almost invariable of HR, Ht, and eGFR at 2, 5, and 10 minutes, but increased with HR ($r=0.77$) and eGFR ($r=0.56$) at 20 minutes (figure 2). M/L of DCM (mean= 0.43, 0.43, 0.49, 0.58 at 2, 5, 10, 20 min, respectively) was significantly higher than that of normal myocardium (mean= 0.33, 0.31, 0.34, 0.39 at 2, 5, 10, 20 min, respectively) ($p < 0.01$).

DISCUSSION AND CONCLUSION

Normal M/L in LGE was almost invariable in time between 2 to 20 minutes after gadolinium administration, and M/L of DCM was significantly higher than normal. The results seem to represent the fact that fibrous tissue and interstitial volume increase in myocardium of DCM even in apparently non-enhanced regions on LGE. In conclusion, M/L can display abnormality in the diffuse myocardial diseases such as DCM.

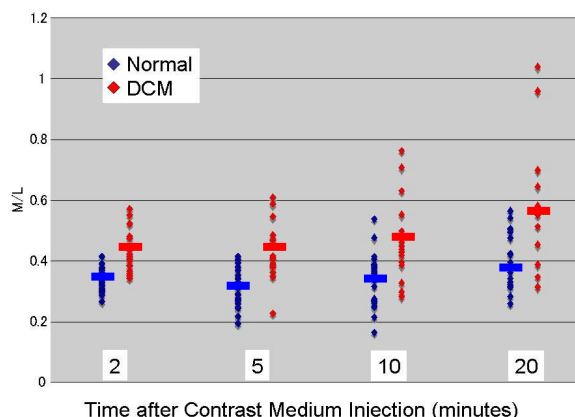


Figure 1 Plot of M/L as a function of time after contrast injection. M/L of DCM is higher at each time point than that of normal myocardium. Bars indicate means.

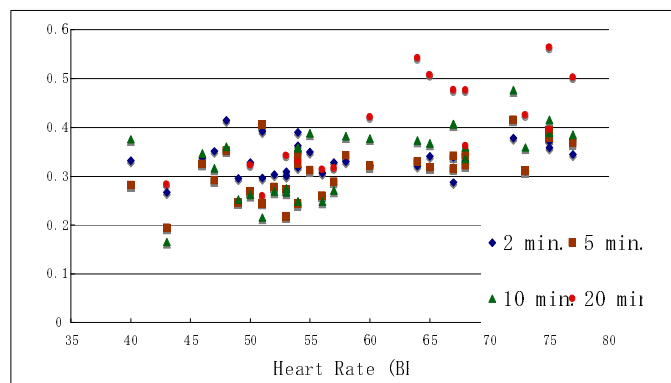


Figure 2 Plot of M/L as a function of heart rate (HR). Normal M/L at 2, 5, 10 are almost independent on HR. M/L increases with HR at 20 minutes.