Quantitative Assessment for Late Gadolinium Enhancement in Normal Myocardium

A. Kono[1,2], N. Yamada[1], M. Higashi[1], S. Kanzaki[1], T. Noguchi[3], K. Sugimura[2], and H. Naito[1]

[1]Department of Radiology and Nuclear Medicine, National Cardiovascular Center, Suita, Osaka, Japan, [2]Department of Radiology, Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan, [3]Division of Cardiology, National Cardiovascular Center, Suita, Osaka, Japan

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, on the contrary, apparently non-enhanced myocardium may not be normal because of diffuse involvement of the myocardium by abnormal tissue. To detect abnormality of apparently non-enhanced myocardium, we quantified myocardial signals as relative value to nearby lumen signals in the left ventricle (M/L). The purpose of this study was to determine variability of normal M/L depending upon time after contrast administration and subject conditions such as heart rate and renal function.

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 axis sections were obtained in a single breath-hold at each time-point.

We reviewed LGE images of normal myocardium from 32 patients (17 men, mean age of 56.9 yrs; range 25-77, 18 with single vessel myocardial ischemia, 14 with conduction abnormality). All examination was performed under sinus rhythm. We set region of interest (ROI) on the myocardium in segments #1, 2, 4, 5 of the American Heart Association in vertical long axis plane and eight-segments (four segments in each of basal and mid ventricular level) in short axis plane, and on blood pool in the left ventricular lumen close to myocardium of each segment, and then myocardium-to-lumen ratio (M/L) was calculated. In patients with myocardial ischemia, ROI in the remote region was selected for analysis.

We evaluated the variability of M/L among the segments at each time point after contrast medium administration. We evaluated also the correlation of M/L with heart rate (HR), hematocrit (Ht) and serum creatinine concentration (Cr). The laboratory data were obtained within one month of cardiac MR.

RESULTS

M/L was measured in a total of 1084 times in 271 regions of normal myocardium from 32 patients, from which 1033 M/L data were used for analysis after excluding 51 M/L data with low SNR. Mean and SD of M/L at each time-point is displayed in figure 1. Although mean M/L was almost invariable from 2 to 10 minutes, M/L at 20 minutes was higher than that from 2 to 10 minutes. Variation of M/L among the segments was sufficiently small. M/L at 20 minutes decreased with Cr (r=-0.54) and HR (-0.38). M/L did not have significant correlation with Cr (range 0.5-1.2mg/dl), HR (range 35-80bpm), and Ht (range 25-55%) at 2 to 10 minutes.

DISCUSSION AND CONCLUSION

M/L of normal myocardium in LGE was almost invariable in time between 2 to 10 minutes after gadolinium administration. Normal M/L was also almost invariable depending upon HR that affect longitudinal relaxation, and Ht and Cr that affect gadolinium concentration in blood. M/L cancels out sensitivity inhomogeneity of surface coil. Thus, if M/L of diseased myocardium exceeds normal range, we can detect abnormality in apparently non-enhanced myocardium in diffuse myocardial diseases such as cardiac amyloidosis, and Fabry disease (Figure 2).

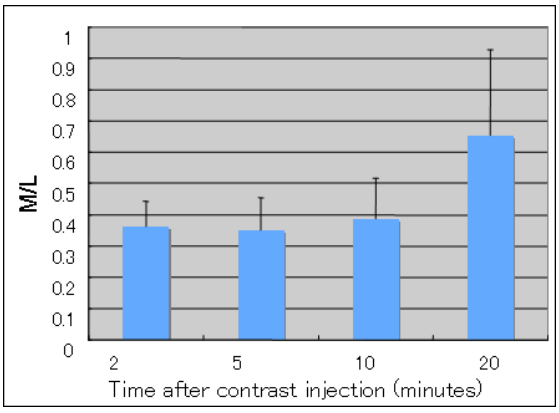
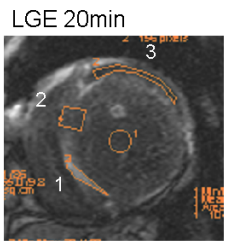


Figure 1 Mean and SD of M/L as a function of time after contrast injection. Error bar indicates 1SD.



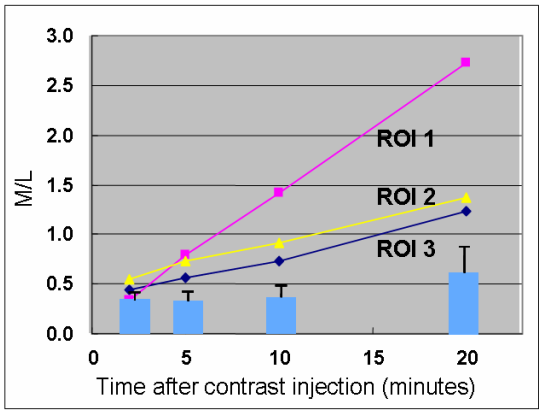


Figure 2 M/L of Fabry disease displays abnormal enhancement at any place of myocardium.