

# 学位論文の要旨

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- 学位論文名 Gadolinium-DTPA-Enhanced Magnetic Resonance Imaging and Functional Outcome in Patients With Acute Myocardial Infarction
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## 論文内容の要旨

### INTRODUCTION

Gadolinium-DTPA(Gd-DTPA)-enhanced magnetic resonance imaging (MRI) is a useful method to diagnose myocardial infarction (MI). As the objective of coronary reperfusion is to limit the extent of myocardial necrosis, it is important to confirm that the severity of the myocardial damage can be measured with Gd-DTPA-MRI during the early stages of ischemia, and to determine whether useful information can be derived from the serial changes in pattern of enhancement of the myocardium by Gd-DTPA-MRI. The present study was designed to determine whether Gd-DTPA enhancement in ischemic myocardium is influenced by the severity of ischemic injury in patients with acute MI. The serial changes of enhancement pattern in Gd-DTPA-MRI was compared with recovery of left ventricular regional wall motion 1 month after the onset of anterior MI.

### MATERIALS AND METHODS

Twenty-nine patients (17 men, 12 women; average age  $62 \pm 2$  years) with acute anterior MI were studied. After informed consent was obtained, the patients undertook right heart catheterization and coronary angiography, followed by percutaneous transluminal coronary angioplasty (PTCA). Left coronary arteriograms were obtained in six projections to evaluate the antegrade flow in the left anterior descending artery. Having identified the culprit lesion, PTCA was performed in all patients to eliminate the possible influence of differences in antegrade

flow on the Gd-DTPA-MRI. After the final inflation, the coronary angiograms were repeated to evaluate the PTCA results, followed by left ventriculogram in two projections. Cardiac catheterization, coronary angiograms and left ventriculogram were repeated 1 month later.

Left ventricular regional wall motion was measured by the centerline method. The RAO 30 degree ventriculograms obtained after primary PTCA and at the 1-month follow-up were reviewed with a computer-based analytical program. The earliest sinus beat was selected and the end-diastolic and end-systolic inner left ventricular contours were traced. Chords 20-40 were chosen for this study because the MRI scanned the mid-ventricular anterior wall.

MRI was performed with a 1.5 Tesla system within 7 days of admission and repeated in all patients 1 month after admission. ECG-gated low flip angle spin-echo imaging was used, with an echo time of 20ms and a repetition time equal to R-R interval of the ECG. After baseline MRI scans were obtained, a 0.1mmol/kg bolus of Gd-DTPA was injected intravenously, and a second image was obtained 15 min later. The same procedure was repeated for the 1-month scans. The Gd-DTPA-MR images were divided into 3 groups based on the degree and pattern of enhancement in the left ventricular anterior wall, as follows: pattern 1 (P1), a distinctly enhanced region in the anterior wall, with a central hypo-enhanced area; pattern 2 (P2), a distinctly enhanced region in the anterior wall; and pattern 3 (P3), no significant enhancement in comparison with the left ventricular inferior wall.

## RESULTS AND DISCUSSION

In the acute phase of MI, P1 was observed in 10, P2 in 11, and P3 in 8 patients. One month later, the image pattern was identical in 9 P1 patients and had changed from P1 to P2 in 1 patient. All patients with P3 images during the acute phase had remained in the enhancement-negative P3 group at 1 month. Of the 11 patients in the P2 group during the acute phase, 7 showed the identical P2 pattern at 1 month, and 4 had a resolution of the enhancement pattern. Patients in the P3 group had lower peak creatine kinase values and higher TIMI flow grades before PTCA than those in the P1 group. No significant difference was observed between the P1 and P2 groups in either peak creatine kinase value or TIMI flow grade during acute phase. Among the patients who had a P2 pattern during the acute phase, significant differences were obtained in both TIMI flow grade and peak creatine kinase between the subgroup with a persistent P2 pattern at 1 month and the subgroup in whom the enhancement pattern had resolved. Q waves were observed on the ECG in all P1 patients (n=10), in 50% of the P2 group (n=11), and in none of the P3 patients during the acute phase.

There were no between-group differences in regional wall motion during the acute phase of MI. In contrast significant differences in regional wall motion, concordant with the Gd-DTPA-MRI classification, were observed at the 1-month follow-up study. In the P1 and P2 patients, regional wall motion at 1 month were nearly identical to those measured during the acute phase. Four P2 patients who had evolved to a P3 pattern at the 1-month follow-up had a

significant recovery of regional wall motion (from  $-2.82 \pm 0.23$  SD/chord to  $-0.90 \pm 0.37$ SD/chord). All patients with P3 patterns during the acute phase of MI also demonstrated a significant recovery of both regional wall motion. Thus, according to this classification by Gd-DTPA-MRI, P1 and P2 patterns at the 1-month follow-up indicated irreversible recent myocardial injury, whereas a P3 pattern was indicative of reversible injury. It is, however, noteworthy that 1/3 of the patients with P3 patterns at the 1-month follow-up had P2 patterns during the acute phase.

The major findings of this study was the ability of Gd-DTPA-MRI to separate patients with identical degree of left ventricular anterior wall dyskinesia in the acute stage of MI into 3 distinct groups characterized by imaging pattern.

Possible explanations for variations in the pattern of enhancement by Gd-DTPA-MRI are the origin of the blood supply (ie, from the infarct-related coronary artery vs collateral vessels), and the myocardial viability. Two distinctive patterns emerged as opposite indicators of myocardial viability in the presence of a dyskinetic anterior left ventricular wall: (1) hyper-enhancement associated with a central hypo-enhanced area, and (2) absence of enhancement. The former pattern was associated with irreversibly injured myocardium, and associated with the development of Q waves on the ECG; the latter pattern was typical of dyskinetic though viable myocardium, also known as stunned myocardium.

In experimental studies, homogeneous contrast enhancement of the myocardium was considered to be characteristic of irreversible injury. However, in the present study, the P2 enhancement-pattern was found in patients with irreversibly, as well as with reversibly, injured myocardium.

## CONCLUSION

Gd-DTPA-enhanced MR images, closely reflecting the severity of myocardial injury, are useful in predicting myocardial functional recovery after MI.

- (1) A central hypo-enhanced area surrounded by a distinct contrast-enhanced region was a pattern indicative of irreversible myocardial damage, which remained nearly unchanged 1 month after infarction, and was associated with no improvement in regional wall motion.
- (2) Two types of evolution were observed in the regional wall motion of patients in whom hyper-enhancement without a central hypo-enhanced region was imaged during the acute phase: in approximately 1/3 of these patients a significant improvement in left ventricular anterior wall motion accompanied the disappearance of enhancement at 1 month; in the other 2/3, the infarcted area remained enhanced with Gd-DTPA, and regional wall motion was unchanged.
- (3) All patients without contrast enhancement in the dyskinetic region during acute MI showed significant functional improvement at 1 month.