

Gadomer - 17¹

. . . 2 . 2 . .

: Gadomer - 17 MRI

. : 5 MRI

. T2 Gadomer - 17 T1 (4 6 , 1 3

) T1

. T2 T1

2,3,5 - triphenyl tetrazolium chloride(TTC)

: T1 Gadomer - 17 가

가 40 60 168%±

9.9 . T2 T1

TTC 가 (p < 0.05).

: Gadomer - 17 MRI 가 가

가 가 , 가 (7, 9).

(magnetic resonance imaging, MRI) Gadolinium - DTPA

가 (intravascular contrast agent) Gadolinium - polylysine

가 (1 - 5). MRI T2 가 가

가 가 , MRI (immunogenecity) 가 (extracellular contrast

가 가 agent) (7).

. Gadolinium - DTPA (extracellular interstitium)

MRI 가 .

Gadolinium - DTPA 가 가

10 - 20% T1

(6 - 8).

Gadomer - 17

¹ Gadomer - 17

² 2000 NMR 2 29 2000 9 4 . 2,3,5 - triphenyl tetrazolium chloride(

:

Gadomer - 17

TTC)

Gadomer - 17

:

(TR)=300msec,

(TE)=25

msec, (field of view)=210×280 mm²,

(slice thickness) = 5mm, (NEX) = 1.

(short axis)

6

(static blood

signal)

(sagittal plane)

5

3.2 Kg

4.1 Kg

3.7 Kg

0.5% (halothane)

(mechanical ventilation, Mini - 7; Royal Medical, Seoul, Korea)

0.6 mg/Kg Pancur -

onium bromide(Panslan; Reyon Pharmaceutical, Seoul, Korea)

(pulse - gating)

(diagonal branch)

(left anterior descending coronary

artery)

가

4 - 0

가

가

가

90

90

MRI

가

Gadomer - 17

T1

(ROI)

3 mm

(circle)

(pixel)

(Contrast Ratio)

= () / ()

(T2

, Gadomer - 17

40

T1

)

TTC

(myocardial mass)

. T2

Gadomer - 17

T1

TTC

paired student t - test

가 (p < 0.05).

1.5T Magnetom VISION system (Siemens,

Erlangen, Germany)

. 27 cm

CP head array (Siemens, Erlangen, Germany)

140 - 170

(ECG -

triggered)

T2

가

. T2

:

(TE) = 82 msec,

(ETL) = 33,

(acquisition time) = 9 - 10 sec,

(matrix size) =

132×256, (field of view)=210×280 mm²,

(slice thickness) = 5 mm. T2

T1

(baseline image)

0.05

mmols/kg Gadomer - 17

(bolus injection)

. Gadomer - 17

T1

4

6

1

3

T1

60

10

, 1

3

30

, 3

6

1

. T1

5

TTC

TTC

2 mm

가

TTC

1 mm

2.5%

12 - 16

5.C (osmotic acid) 2
(Epon) 812 1:1
12 - 16 LKB
ultramicrotome(Bromma, Sweden) 0.5 μ m
4%
(uranyl acetate)

Gadomer - 17 T1
Gadomer - 17 20
가 40 60
168% \pm 9.9
(Fig. 1, 2).
TTC Gadomer - 17
T2 Gadomer - 17
T1 TTC
가 (T2 = 48.1%
 \pm 3.7, Gadomer - 17 = 47.2% \pm 2.6 vs. TTC = 38.7% \pm 3.1; $p < 0.05$) (Fig. 3).
3
가

5 가
(Fig. 4).

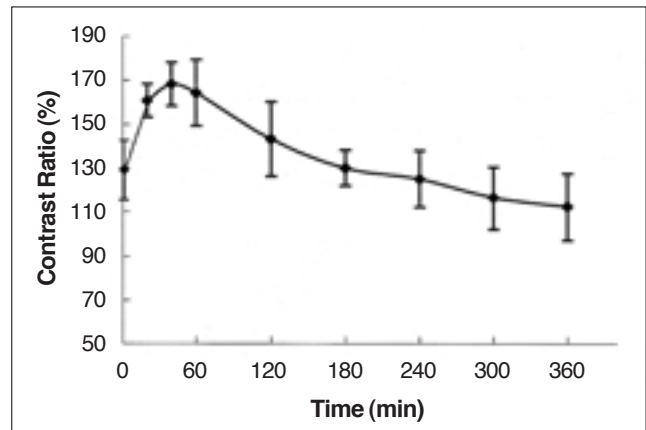


Fig. 1. The time-course of signal enhancement after administration of Gadomer-17. Gadomer-17 enhanced T1-weighted images are obtained for 6 hours in four cats and for three hours in one cat. The enhanced area on Gadomer-17 enhanced T1-weighted images shows a rapid increase of signal intensity from the immediate period to 20 minutes. Maximum enhancement is detected during 40 - 60 minutes with average enhancement of 168% \pm 9.9 of normal myocardium after administration of Gadomer-17.

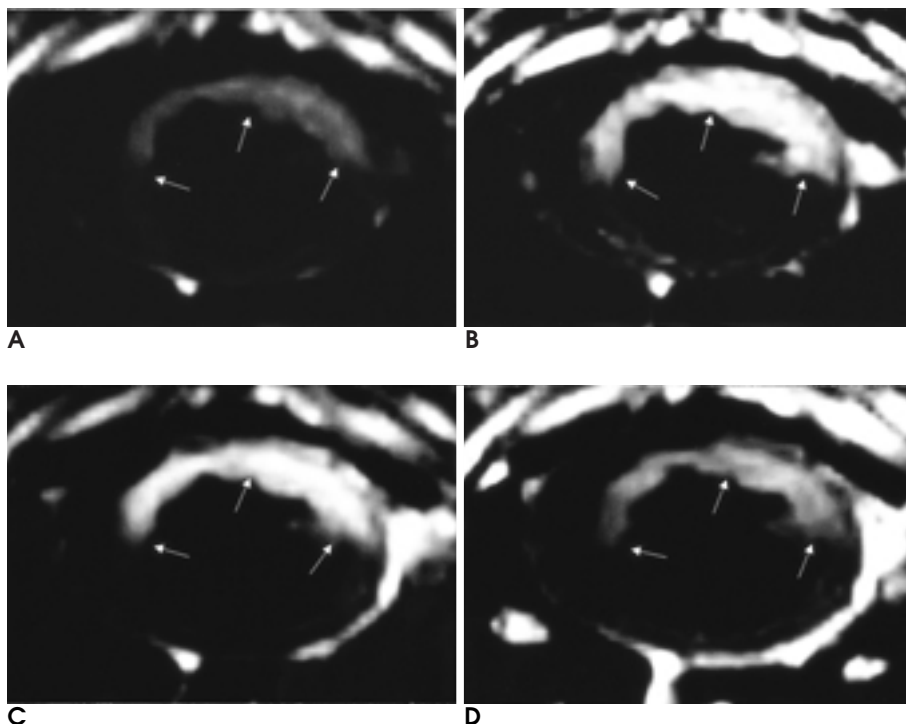


Fig. 2. Example of MR images of time-course of enhancement.

A. T2-weighted turbo spin-echo image shows the area of high signal intensity in the territory of left anterior descending coronary artery (arrows).

B. Non-enhanced T1-weighted turbo spin-echo image shows slightly high signal intensity in the corresponding area (arrows), which means hemorrhagic infarction.

C. Gadomer-17 enhanced T1-weighted turbo spin-echo image obtained in 40 minutes after administration of Gadomer-17 shows strong high signal intensity (arrows).

D. The signal intensity of the enhanced area (arrows) on Gadomer-17 enhanced T1-weighted turbo spin-echo image obtained in 3 hours after administration of Gadomer-17 is decreased.

• •

Gadomer - 17

TTC

T1

Gadomer - 17

2

40 60

9%

3

가

가

(10)

Thallium - SPECT

95%

T2

가

가

(11 - 12).

T1

가

가

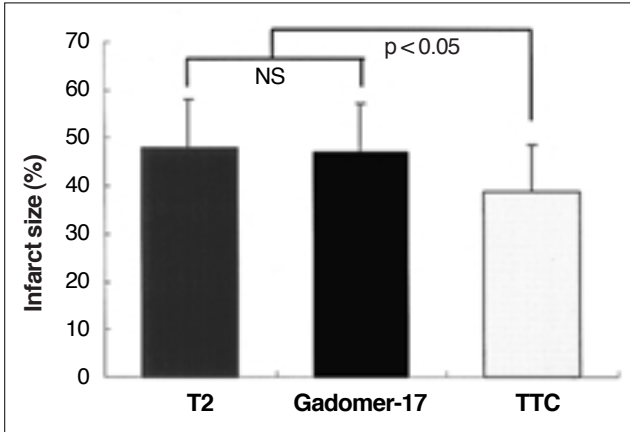


Fig. 3. Comparison between the abnormal signal area on MRI and infarct area on TTC histochemical staining. The size of the high signal area on T2-weighted images and the enhanced area on Gadomer-17 enhanced T1-weighted MR images is larger than that of infarct area on TTC histochemical staining. NS: not significant, TTC: 2, 3, 5-triphenyl tetrazolium chloride.

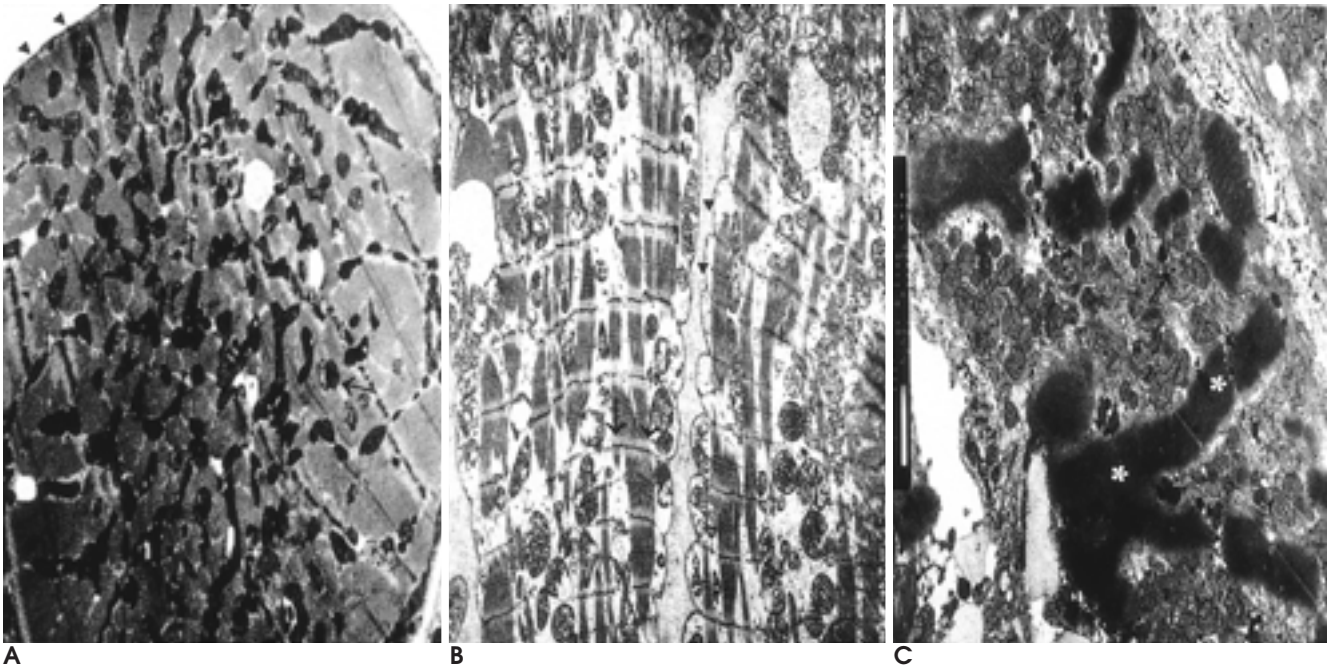


Fig. 4. The ultrastructural features of myocardium on electron microscopic examination.

A. Ultrastructure of normal myocardium. Myocardial cells are surrounded by an intact sarcolemma (arrowheads) and mitochondria are abundant (arrow).

B. Ultrastructure of the peri-infarct area shows interfiber edema, intramitochondrial edema, and prominent I-bands (arrows). The sarcolemma is intact (arrowheads). These findings are consistent with the ultrastructural changes of reversibly injured myocardium.

C. Ultrastructure of the infarct area. The sarcolemma are markedly disrupted (arrowheads). The mitochondria are swollen and contained electron-opaque granular dense bodies (arrow). Contraction bands(asterisks) are also seen.

(13 - 15). Gadolinium -
DTPA T2 가

Gadolinium - DTPA
(extracellular space)

가 (7).
Gadomer - 17
가
Gadomer - 17 24 - Gd - macrocyclic -
dendrimer 17453 g/mol
Gadolinium - DTPA 가

, Gadomer - 17

Gadolinium -
DTPA 가

Gadophrin - 2(Schering AG, Berlin)가
, 가 Gadophrin - 2
가

(16 - 18). Saeed
(17) 가 가
Gadolinium - DTPA 가
Gadophrin - 2

T1 가
가
가
Gadophrin - 2 가 가
Gadomer - 17 가
(coronary MR angiography)

(19).
gadomer - 17
17 Gadomer - 17 가
가
가 Gadophrin - 2
MRI 가
가

1. Wilke N, Kroll K, Wang Y, et al. Regional myocardial blood volume and flow: first-pass MR imaging with polylysine-Gd-DTPA. *J Magn Reson Imaging* 1995;5:227-237
2. Wilke N, Simm N, Zhang K, et al. Contrast-enhanced first-pass myocardial perfusion imaging: Correlation between myocardial blood flow in dogs at rest and during hyperemia. *Magn Reson Med* 1993;29:485-497
3. Wyttenbach R, Saeed M, Wendland MF, et al. Detection of acute myocardial ischemia using first-pass dynamics of MnDPDP on inversion recovery echo planar imaging. *J Magn Reson Imaging* 1999; 9:209-214
4. Lim T-H, Lee JH, Gong GY, Park S-J, Lee IC. Significance of MR signal enhancement in evaluation of myocardial infarction in cats. *Invest Radiol* 1995;302:306-314
5. Atkinson DJ, Burstein D, Edelman RR. Evaluation of first-pass cardiac perfusion by ultrafast MR imaging. *Radiology* 1990;174:757-762
6. Judd RM, Lugo OC, Aria M, et al. Physiological basis of myocardial contrast enhancement in fast magnetic resonance imaging of 2-day old reperfused canine infarct. *Circulation* 1995;92:1902-1910
7. Lim T-H, Lee JH, Lee TK, Mun CW. Comparison of Gadolinium polylysine and Gadopentetate in contrast enhanced MR imaging of myocardial ischemia-reperfusion in cats. *J Korean Radiol Soc* 1995; 33:59-65
8. Choi SH, Jiang CZ, Lee TK, et al. Myocardial assessment during subacute stage after ischemia-reperfusion: Gd-DTPA-polylysine enhanced MR imaging in cats. *J Korean Radiol Soc* 1998;39:1069-1073
9. Wendland MF, Saeed M, Lund G, Higgins CB. Contrast-enhanced MRI for quantification of myocardial viability. *J Magn Reson Imaging* 1999;10:694-702
10. Lim T-H, Hong MK, Lee JS, et al. Novel application of breath-hold turbo spin-echo T2 MRI for detection of acute myocardial infarction. *J Magn Reson Imaging* 1997;7:996-1001
11. Johnston D, Thompson R, Liu P. Magnetic resonance imaging during acute myocardial infarction. *Am J Cardiol* 1986;58:214-219
12. Adzhamli IK, Blau M, Pfeffer MA, Bavis MA. Phosphonate-modified Gd-DTPA complexes. III: the detection of myocardial infarction by MRI. *Magn Reson Med* 1993;29:505-511
13. Saeed M, Wendland MF, Takehara Y, Higgins CB. Reversible and irreversible injury in the reperfused myocardium: differentiation with contrast material enhanced MR imaging. *Radiology* 1990;175: 633-637
14. McNamara MT, Tscholakoff D, Revel D, et al. Differentiation of reversible and irreversible myocardial injury by MR imaging with or without Gadolinium-DTPA. *Radiology* 1986;158:765-769
15. Pereira RS, Prato FS, Wisenberg G, Sykes J. The determination of myocardial viability using Gd-DTPA in a canine model of acute myocardial ischemia and reperfusion. *Magn Reson Med* 1996;36: 684-693
16. Choi SI, Choi SH, Kim ST, et al. Irreversibly Damaged Myocardium at MR Imaging with a Necrotic Tissue-Specific Contrast Agent in a Cat Model. *Radiology* 2000;215:863-868
17. Saeed M, Bremerich J, Wendland MF, Weinmann HJ, Higgins CB. Reperfused myocardial infarction as seen with use of necrosis-specific versus standard extracellular MR contrast media in rats. *Radiology* 1999;213:247-257
18. Marchal G, Ni Y, Flameng W, et al. Paramagnetic metallopor-

phyrin: infarct avid contrast agents for diagnosis of acute myocardial infarction by MRI. *Eur Radiology* 1996;6:2-8

19. Lorenz CH, Johansson LO. Contrast-enhanced coronary MRA. *J Magn Reson Imaging* 1999;10:703-708

J Korean Radiol Soc 2000;43:539 - 544

Gadomer-17 in Contrast Enhanced MR Imaging of Reperfused Myocardial Infarction in a Cat Model¹

Han Na Noh, M.D., Sang Il Choi, M.D., Seong Hoon Choi, M.D., Sang Tae Kim, BS.²,
Keun Ho Lim, BS.², Chung Hwan Lim, RT., Tae-Hwan Lim, M.D.

¹Department of Radiology, Asan Medical Center, University of Ulsan College of Medicine

²NMR Laboratory, Asan Institute for Life Sciences

Purpose: To evaluate in reperfused myocardial infarction in a cat model, the time-course of signal enhancement as seen on Gadomer-17 enhanced MRI, and to correlate the size of the enhanced area with that of the infarct area as revealed by on histochemical examination.

Materials and Methods: Five cats which had undergone occlusion of the LAD followed by reperfusion underwent MR imaging. After T2-weighted imaging, Gadomer-17 enhanced T1-weighted images were obtained in four cats during a six-hour period, and in one during a three-hour period. Signal intensities were measured in the enhanced and non-enhanced areas of enhanced T1-weighted images. and using 2,3,5-triphenyl tetrazolium chloride (TTC) histochemical staining, the size of the abnormal signal area on each image was compared with that of the infarct area.

Results: The enhanced area seen on enhanced T1-weighted images showed rapidly increased signal intensity following the administration of Gadomer-17. Maximum enhancement was detected during a 40 - 60 minutes period, with an average enhancement of $168 \pm 9.9\%$ of normal myocardium. TTC staining revealed that the size of the high signal area on T2-weighted images and of the enhanced area on enhanced T1-weighted images was greater than that of the infarct area ($p < 0.05$).

Conclusion: In reperfused myocardial infarction in a cat model, Gadomer-17 enhanced MR imaging delineates both reversibly and irreversibly damaged myocardium, with strong enhancement and a broad temporal window. We may therefore expect that Gadomer-17 is useful for demonstrating myocardial injury.

Index words : Myocardium, infarction
Magnetic resonance (MR), contrast agent

Address reprint requests to : Tae-Hwan Lim, M.D., Department of Radiology, Asan Medical Center, University of Ulsan College of Medicine
388-1 PoongNap-Dong, SongPa-Ku, Seoul 138-746, Korea.
Tel. 82-2-2224-4364 Fax. 82-2-476-4719 E-mail: thlim@www.amc.seoul.kr