

CT T1WI, FLAIR, GRE MR

1

CT T1WI FLAIR GRE MR
 CT 53
 CT T1WI, FLAIR, GRE MR
 0, 1, 2 2
 가 CT MR
 Wilcoxon signed ranks test
 3 - 14 7.6
 CT 53 26
 T1WI FLAIR MR CT ($p<0.05$),
 GRE MR CT ($p=0.5$). GRE MR
 CT A 5, B 2 가
 가
 : GRE MR T1WI FLAIR MR
 , CT

- (1). (1, 4, 6 - 10) (fluid attenuated inversion recovery, FLAIR) (11,12)
 . GRE SE 180° (RF refocusing pulse) (gra - dient refocusing pulse) (mag - netic susceptibility) 가 (6, 10).
 CT MR
 (computerized tomography, CT) 가 CT MR (7, 8), CT
 (3). (magnetic resonance imaging, MRI) MRI (8),
 (7)
 , 12
 CT 가
 (1, 4, 5). TI (T1 - weighted image:
 CT 가 T1WI) FLAIR, GRE MR
 CT
 (spin echo, SE) GRE MR 가
 (gradient echo, GRE)

2001 12 2003 2

MR (diffusion-weighted image, DWI)

53

가

11

CT 12

가

CT MRI 2.5 - 9

5.3

14 7.6

CT QX/i LightSpeed (GE medical system, Milwaukee, U.S.A.) High Speed Advantage (GE medical system, Milwaukee, U.S.A.) 120 kVp, 200 mA, 5 - 10 mm, 5 mm

MRI 1.5 T (Horizon Echospeed, GE medical system, Milwaukee, U.S.A.)

T1 FLAIR, GRE MR 3D-TOF MR (MR angiography, MRA)

가 T1 TR 450 - 500 msec, TE 8 msec, FLAIR TR 10000 msec, TE 120 msec, TI 2200 msec, GRE TR 300 - 500 msec, TE 20 msec, flip angle 20 °; MRA TR 33 msec, TE 6.9 msec, flip angle 20 °; band width 15.6 kHz

5 mm, 1.5 mm, 256 × 192, 24 - 31, 23 × 17 - 22 cm

가 CT MR

CT 가 , MR T1

, FLAIR GRE

(signal void) 가

CT MR (region of interest, ROI) Hounsfield units (contrast - to - noise ratio, CNR)

CT MR

0 , 1 , 2

CT

Wilcoxon signed ranks test (p value < 0.05) CT MRI

CT 53 A B 29

3

26 (Fig. 1). 17:9

43 - 84 (58.1) MRA

12 , 9 ,

2 , 3

12.7 - 17.5 mg/dL (14.6 mg/dL)

GRE A 7 1 , 19 2

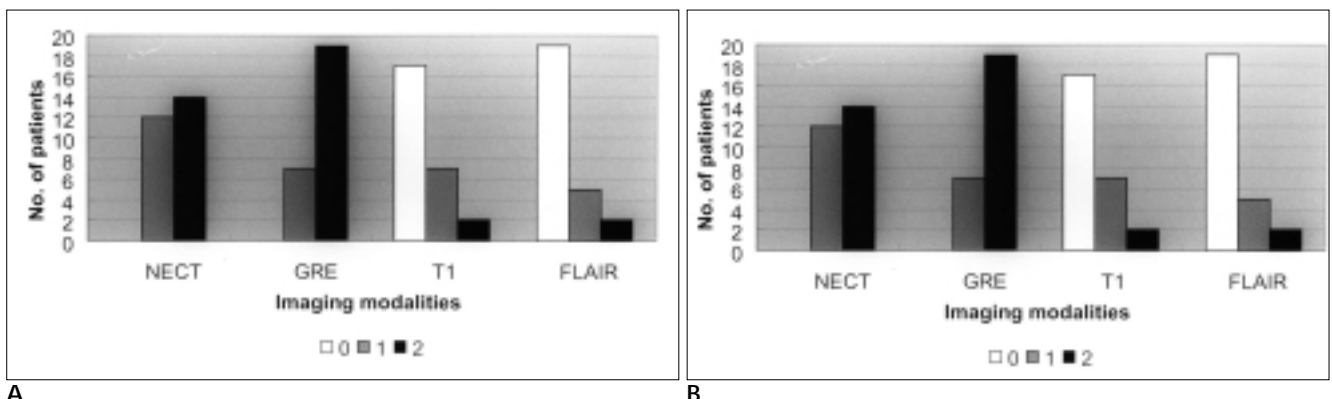
, B 8 1 , 18 2 CT

. T1WI A 9 ,

B 10 , FLAIR

A, B 7 (Table 1).

Wilcoxon signed ranks test



A
Fig. 1. Patients with hemorrhagic transformation detected on nonenhanced CT, T1WI, FLAIR, and GRE MR imagings.
A. Reader A.
B. Reader B.
Score: 0-none, 1-suspicious, 2-sure

, T1WI FLAIR
 CT
 (p<0.05), CT
 GRE 180 °
 (p=0.50) (Table 2).
 GRE B 2 CT A 5 ,
 가 (Fig.
 2). SE 180 °
 (susceptibility - induced
 (p>0.05) dephasing) (rephasing)
 (Table 2). SE TE가 GRE
 가 (flip angle)
 가
 MRI (paramagnetic effect)가 MR CT
 (oxyhemoglobin)가
 (1, 3, 13, Table 2. Statistical Comparison of CT with T1WI, FLAIR, and
 14). 12 GRE MR Imaging in Detection of Hemorrhagic Transformation,
 MR CT 가 (1, 4, 5). and Statistical Difference between Two Readers
 MR 가 , Linfante (15) 2

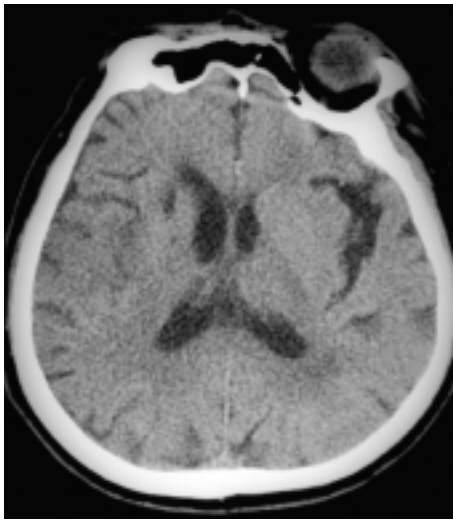
	CT-T1WI	CT-FLAIR	CT-GRE	Reader A-B
Exact Sig.(p value)	0.003	0.002	0.5	0.8

Table 1. Score of Lesion Conspicuity in 26 Patients with Hemorrhagic Transformation

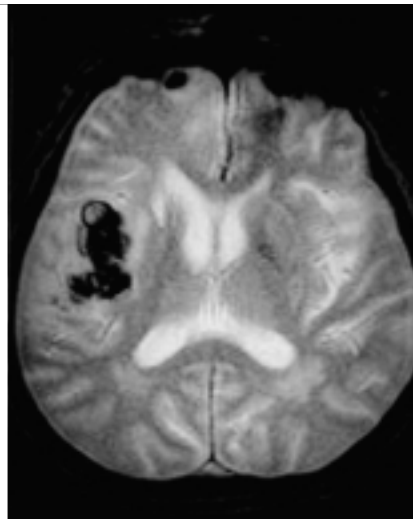
Patients No.	Score of Lesion Conspicuity							
	NECT		T1WI		FLAIR		GRE	
	A	B	A	B	A	B	A	B
1	2	2	0	1	0	0	2	2
2	1	1	0	0	0	0	1	1
3	2	2	2	2	2	2	2	2
4	1	1	0	0	0	0	2	2
5	1	1	0	0	0	0	1	1
6	2	2	1	1	1	1	2	1
7	2	1	0	0	0	0	2	2
8	1	1	1	1	1	1	2	2
9	2	2	1	1	1	1	2	2
10	2	2	0	0	0	0	2	2
11	1	1	0	0	0	0	2	2
12	1	2	0	0	0	0	1	1
13	1	2	0	0	0	0	2	2
14	2	2	0	0	0	0	2	1
15	1	1	0	0	0	0	2	2
16	2	2	0	0	0	0	1	1
17	2	2	1	1	0	0	2	2
18	2	2	1	1	1	1	2	2
19	1	1	0	0	0	0	2	2
20	2	2	1	1	0	0	2	2
21	1	1	0	0	0	0	1	2
22	2	2	0	0	0	0	2	2
23	2	2	2	2	2	2	2	2
24	1	2	0	0	0	0	1	1
25	1	1	0	0	0	0	1	1
26	2	2	1	1	1	1	2	2

A-reader A; B-reader B

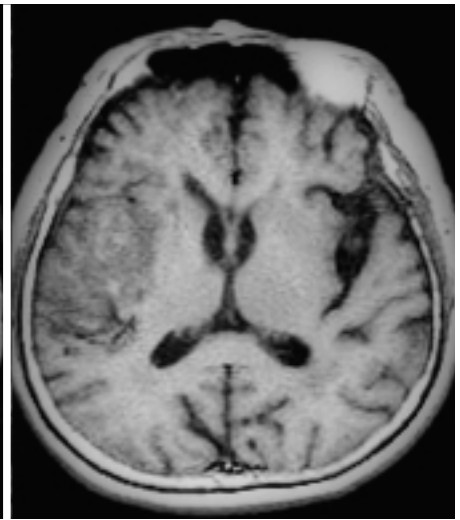
Score: 0-none, 1-suspicious, 2-sure



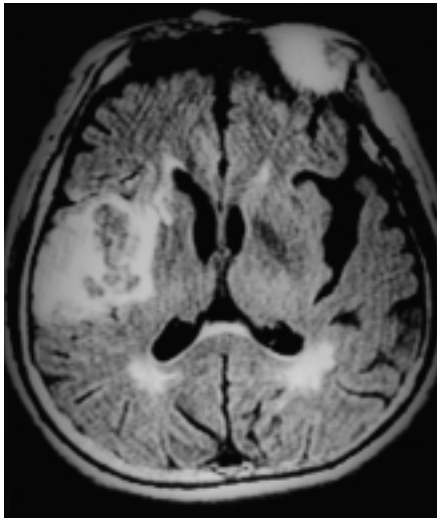
A



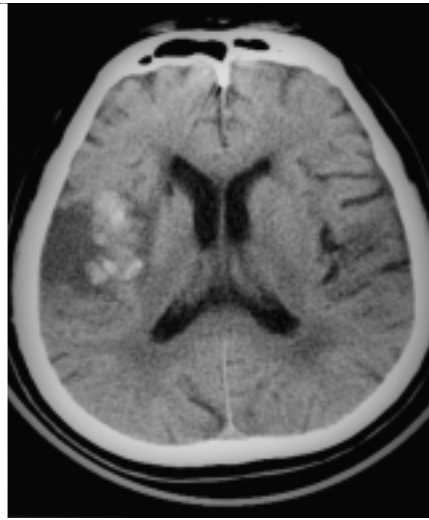
B



C



D



E

Fig. 2. A 62-year-old man with left hemiplegia. CT was performed 8 hours and MRI 13 hours after symptom onset (patient No.8).

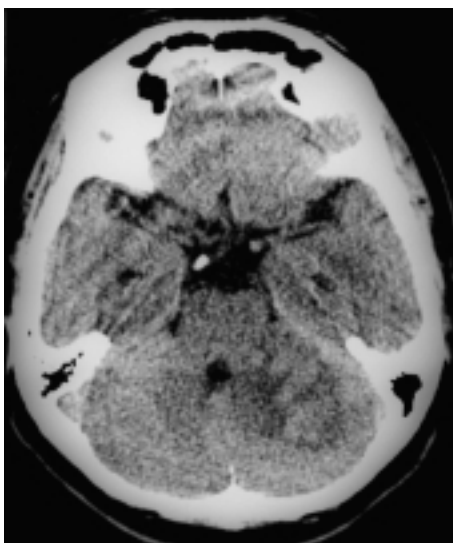
A. Initial CT demonstrates low attenuated lesion in right temporal lobe with subtle high attenuated foci.

B. After 5 hours, gradient-echo MR image shows low signal intensity area within high signal intensity lesion of right temporal lobe.

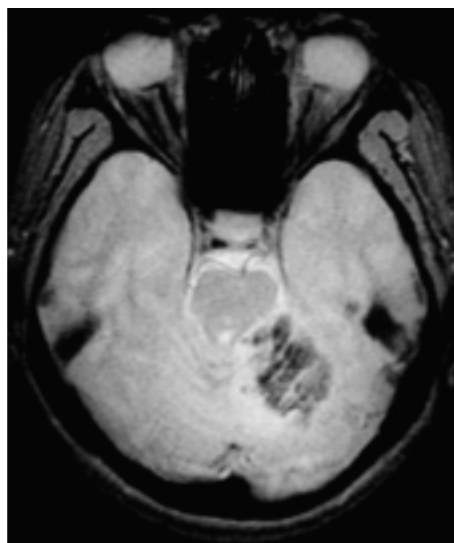
C. Axial T1-weighted image shows low signal intensity lesion in right temporal lobe with slightly high signal intensity foci.

D. FLAIR MR image shows bright signal intensity lesion in right temporal lobe with low to iso signal intensity foci.

E. Follow-up CT after 2days shows discrete hemorrhagic transformation within infarcted low attenuated area of right temporal lobe.



A



B

Fig. 3. A 58-year-old man with headache. CT was performed 9 hours and MRI 12 hours after symptom onset (patient No.3).

A. Initial CT demonstrates hemorrhagic transformation within infarcted low attenuated area of left cerebellum.

B. After 3 hours, gradient-echo MR image shows low signal intensity area within high signal intensity lesion of left cerebellum.

units, MR, CT, MR

CT 53 26 가
 CT GRE MR A, B CT
 26 A
 5, B 2 CT
 CT MR 3
 CT GRE MR
 (Fig. 3).
 GRE MR CT
 가
 가 CT
 (17) GRE MR
 가
 MR

(sequence) - (SE - EPI)

DWI GRE
 DWI GRE

CT
 T1WI FLAIR A, B
 CT T1WI
 가 (ferrous ion)
 (hydrophobic cleft)
 (proton electron
 dipole dipole interaction, PEDD interaction)
 T1 (17). 12
 T1
 FLAIR
 (11, 12) CT
 FLAIR
 7.6 CT MRI
 MRI CT MRI
 1 (17)
 CT MRI
 CT MRI
 가 가
 Schellinger (7)
 (ROI) CT Hounsfield

1. Seidenwurm D, Meng TK, Kowalski H, Weinreb JC, Kricheff II. Intracranial hemorrhagic lesions: evaluation with spin-echo and gradient-refocused MR imaging at 0.5T and 1.5T. *Radiology* 1989;172:189-194
2. Han MC, Park JH. *Interventional radiology*. Seoul: Ilchokak, 1999;452-456
3. Bradley WG Jr. MR appearance of hemorrhage in the brain. *Radiology* 1993;189:15-26
4. Lin DD, Filippi CG, Steever AB, Zimmerman RD. Detection of intracranial hemorrhage: comparison between gradient-echo images and b0 images obtained from diffusion-weighted echo-planar sequences. *AJNR Am J Neuroradiol* 2001;22:1275-1281
5. Kuker W, Thiex R, Rohde I, Rohde V, Thron A. Experimental acute intracerebral hemorrhage. Value of MR sequences for a safe diagnosis at 1.5 and 0.5 T. *Acta Radiol* 2000;41:544-552
6. Liang L, Korogi Y, Sugahara T, et al. Detection of intracranial hemorrhage with susceptibility-weighted MR sequences. *AJNR Am J Neuroradiol* 1999;20:1527-1534
7. Schellinger PD, Jansen O, Fiebach JB, Hacke W, Sartor K. A standardized MRI stroke protocol: comparison with CT in hyperacute intracerebral hemorrhage. *Stroke* 1999;30:765-768
8. Patel MR, Edelman RR, Warach S. Detection of hyperacute primary intraparenchymal hemorrhage by magnetic resonance imaging. *Stroke* 1996;27:2321-2324
9. Weingarten K, Zimmerman RD, Deo-Narine V, Markisz J, Cahill PT, Deck MD. MR imaging of acute intracranial hemorrhage: findings on sequential spin-echo and gradient-echo images in a dog model. *AJNR Am J Neuroradiol* 1991;12:457-467
10. Atlas SW, Mark AS, Grossman RI, Gomori JM. Intracranial hemorrhage: gradient-echo MR imaging at 1.5 T. Comparison with spin-echo imaging and clinical applications. *Radiology* 1988;168:803-807
11. Noguchi K, Seto H, Kamisaki Y, Tomizawa G, Toyoshima S, Watanabe N. Comparison of fluid-attenuated inversion-recovery MR imaging with CT in a simulated model of acute subarachnoid hemorrhage. *AJNR Am J Neuroradiol* 2000;21:923-927
12. FLAIR MR : CT T1 MR
 2000;42:425-430

13. Gomori JM, Grossman RI. Mechanisms responsible for the MR appearance and evolution of intracranial hemorrhage. *Radiographics* 1988;8:427-440
14. Clark RA, Watanabe AT, Bradley WGJr, Roberts JD. Acute hematomas: effects of deoxygenation, hematocrit, and fibrin-clot formation and retraction on T2 shortening. *Radiology* 1990;175: 201-206
15. Linfante I, Llinas RH, Caplan LR, Warach S. MRI features of intracerebral hemorrhage within 2 hours from symptom onset. *Stroke* 1999;30:2263-2267
16. Fazekas F, Kleinert R, Roob G, et al. Histopathologic analysis of foci of signal loss on gradient-echo T2*-weighted MR images in patients with spontaneous intracerebral hemorrhage: evidence of microangiopathy-related microbleeds. *AJNR Am J Neuroradiol* 1999;20:637-642
17. Osborn AG. *Diagnostic neuroradiology*. St. Louis: Mosby, 1994:160-167, 344-350

J Korean Radiol Soc 2003;49:1 - 6

Detection of Hemorrhagic Transformation in Patients with Acute Cerebral Infarction: Comparison of CT with T1WI, FLAIR, and Gradient-Echo MR Imaging¹

Seok Kyun Chung, M.D., Jeong Jin Seo, M.D., Woong Yoon, M.D., Yong Yeon Jeong, M.D.,
Tae Woong Chung, M.D., Gwang Woo Jeong, M.D., Heoung Keun Kang, M.D.

¹Department of Diagnostic Radiology, Chonnam National University Hospital, School of Medicine

Purpose: To determine the diagnostic accuracy of T1-weighted, FLAIR, and GRE MR imagings in the detection of hemorrhagic transformation in patients with acute cerebral infarction and to compare it with CT.

Materials and Methods: Fifty-three patients with acute territorial cerebral infarction were studied prospectively. All patients underwent nonenhanced CT and MRI including the T1-weighted, FLAIR, and GRE. Lesion conspicuity of hemorrhage was scored as follows: 0-none; 1-suspicious; 2-sure. CT and MR imagings were reviewed two radiologists respectively. The mean value of the lesion conspicuity in each CT and MR sequences was compared by means of a Wilcoxon signed ranks test. The time intervals between CT and MR imagings ranged from 3 to 14 hours (mean; 7.6 hours).

Results: Hemorrhagic transformation was detected on nonenhanced CT in 26 of 53 patients. In the detection of hemorrhage in patients with acute cerebral infarction, T1-weighted and FLAIR MR imagings were inferior to NECT ($p < 0.05$). By contrast, lesion conspicuity of GRE MR imaging was not different from that of CT ($p = 0.5$). In addition, lesion conspicuity of GRE MR imaging was greater than that of CT in five patients on reader A and two patients on reader B.

Conclusion: GRE MR imaging was superior to T1-weighted and FLAIR MR imagings, equal to nonenhanced CT in the detection of hemorrhagic transformation in patients with acute cerebral infarction.

Index words : Brain, infarction
Hemorrhage, CT
Hemorrhage, MR

Address reprint requests to : Jeong Jin Seo, M.D., Department of Diagnostic Radiology, Chonnam National University Hospital, School of Medicine, 8 Hak-dong, Dong-gu, Gwang-ju 501-757, Korea.
Tel. 82-62-220-5745 Fax. 82-62-226-4380 E-mail: jjseo@chonnam.ac.kr