Oscillating Gradient Spin Echo（OGSE）法を用いた拡散時間の短い拡散強調像による急性期脳梗塞の病態分析［大会長賞記録］

越野沙織[1,2]，クリスティナアンディカ[1]，堀　正明[1]，鈴木通真[1]，
萩原彰文[1,2]，神谷昂平[1,2]，前川朋子[1,2]，入江隆介[1,2]，
福永一星[1]，村田　渉[1]，堀田萌子[1,3]，武中祐樹[1,3]，
青木茂樹[1]

[1]順天堂大学医学部附属順天堂医院放射線科・部
[2]東京大学大学院医学系研究科放射線医学講座
[3]首都大学東京人間健康科学研究科放射線科学域

目　　的

Oscillating gradient spin echo（OGSE）法は拡散時間の短縮化により微細構造を観察する手法として期待されている[1)~3)]．本研究では，急性期脳梗塞の症例において，従来（Pulsed Gradient Spin Echo : PGSE）の拡散強調像（Diffusion Weighted Imaging : DWI）とOGSE 法による拡散強調像を比較し，急性期脳梗塞の微細構造の変化を分析することを目的とする．

方　　法

OGSE 法で撮像された発症時刻の明らかな急性期脳梗塞 22 例（男性 18 例，女性 4 例，平均年齢 69.1 歳）を対象とした．3T MRI（MAGNETOM Prisma，Siemens 社）を用いて，b 値 0 s/mm^2，1500 s/mm^2 で周波数を 0 Hz（拡散時間 47.3 ms，PGSE），50 Hz（拡散時間 8.5 ms，OGSE）に設定して撮像した．各々の拡散強調像で 27 病変部の ADC（apparent diffusion coefficient）値を求め，発症からの時間における変動を検討した．

結果と考察

発症からの日数により，PGSE での ADC 値と OGSE での ADC 値の比の平均値は，0.741（0～1 日後），0.798（2～5 日後），0.691（6～9 日後），0.774（10～12 日後）と変動した（Fig. 1）．今回見られた変化は，各々次のような微細構造の変化に対応すると考えられた．

（1）0～1 日後：細胞性浮腫[4),5)]

（2）2～5 日後：細胞基質の構造の乱れによる細胞内粘稠度の増加や，細胞外拡散の各種要素による変化

（3）6～9 日後：細胞自体の構造の破壊

（4）10～12 日後：細胞内液と外液の混和

また，各々の代表例において，発症から 0～1 日後の OGSE での DWI や，6～9 日の OGSE での ADC map では，病変部が観察されなかった（Fig. 2）．b 値と同様，拡散時間が DWI や ADC map の見え方に重要であることが示唆された．

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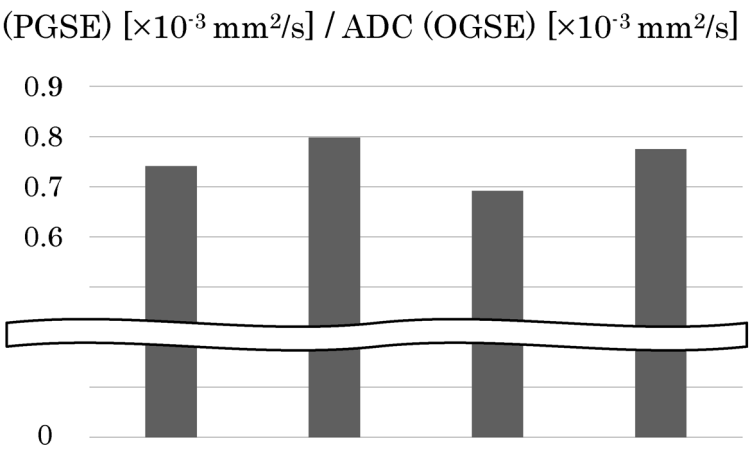
キーワード　oscillating gradient spin echo（OGSE），diffusion weighted imaging（DWI），acute cerebral infarction, microstructural change



From onset	Day 0-1	Day 2-5	Day 6-9	Day 10-12
Number of lesions	10	6	8	3
ADC (PGSE)	323	347	354	364
ADC (OGSE)	436	435	512	470

Fig. 1. Ratios of ADC (PGSE) to ADC (OGSE) [$\times 10^{-3}$ mm^2/s] in the case of acute cerebral infarction. ''ADC (PGSE)/ADC (OGSE) ≒ 1'' means free restriction. ''ADC (PGSE)/ADC (OGSE) ≒ 0.6'' can mean strong spatial restriction. The ratios fluctuated along the time course from the onset of acute infarction, which may reflect the tendency of microstructure changes as follows : Day 0–1 & 6–9, spatial restriction ; Day 2–5 & 10–12, viscosity. The ratios of ADC values may gradually approach to 1 because the lesion finally changes to cerebrospinal fluid.

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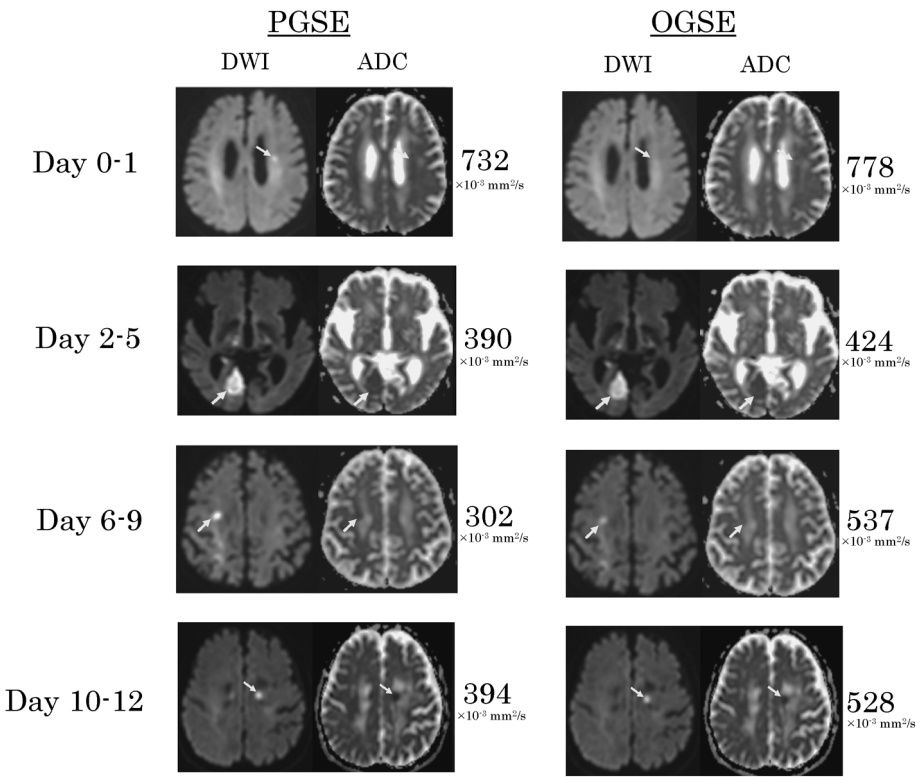

Fig. 2. DWI and ADC maps along the time course with ADC values. In the case of day 0–1, the lesion on DWI of OGSE disappeared. Remarkably, in the case of day 6–9, the lesion on ADC map of OGSE also disappeared, which may suggest that diffusion time as well as b value should be related to the appearance of DWI/ADC map.

Oscillating Gradient Spin Echo（OGSE）Diffusion Weighted Imaging of the Acute Cerebral Infarction［Presidential Award Proceedings］

Saori KOSHINO[1,2], Christina ANDICA[1], Masaaki HORI[1], Michimasa SUZUKI[1], Akifumi HAGIWARA[1,2], Kouhei KAMIYA[1,2], Tomoko MAEKAWA[1,2], Ryusuke IRIE[1,2], Issei FUKUNAGA[1], Syo MURATA[1], Moeko HORITA[1,3], Yuki TAKENAKA[1,3], Shigeki AOKI[1]

[1]*Department of Radiology, Juntendo University School of Medicine 2–1–1 Hongo, Bunkyo-ku, Tokyo 113–8421*
[2]*Department of Radiology, Graduate School of Medicine, The University of Tokyo*
[3]*Department of Radiological Sciences, Graduate School of Human Health Sciences, Tokyo Metropolitan University*

The oscillating gradient spin echo（OGSE）sequence enables measurement of diffusion weighting with a short diffusion time. The apparent diffusion coefficient（ADC）values of diffusion-weighted imaging（DWI）depend on the effective diffusion time（Δ_{eff}）, which is the time allowed for water molecules to diffuse and probe the microstructural information in vivo. The aim of this study was to determine the utility of DWI with shorter diffusion times when observing microstructural changes due to acute cerebral infarction.

Twenty-seven lesions in 22 subjects（18 men and 4 women ; mean age, 69.1 years）with acute cerebral infarction were observed. A 3T MR scanner（MAGNETOM Prisma, Siemens Healthcare, Erlangen, Germany）with a 20-channel head coil was used. DWI was performed using b-values of 0 and 1500 s/mm^2 and three diffusion-encoding directions with the following parameters : Δ_{eff} of the pulsed gradient spin echo（PGSE）, 47.3 ms ; Δ_{eff} of the OGSE, 8.5 ms. On the DWI/ADC map, one region of interest was placed within the lesion of an acute cerebral infarction.

The ratios of the PGSE ADC values to the OGSE ADC values fluctuated during the time course after the onset of acute cerebral infarction. This fluctuation can be caused by microstructural changes, which may lead to structurally restricted diffusion and/or viscosity. No study has determined the relationship between ADC values with such a short diffusion time and time course from the onset of acute cerebral infarction in a live human brain. In vivo, the ADC measured in the lesion of the acute brain infarction of a live adult mouse brain presented tissue-dependent frequency dependence. This study suggests that a human ADC should also depend on the diffusion time, with non-invasive OGSE methods.