

# Prediction of the onset day using by T2\*-weighted magnetic resonance imaging in patients with subarachnoid hemorrhage

Takashi Inoue<sup>1</sup>, Miki Fujimura<sup>2</sup>, Kuniyasu Niizuma<sup>2</sup>, and Teiji Tominaga<sup>2</sup>

<sup>1</sup>Neurosurgery, Sendai Medical Center, Sendai, Miyagi, Japan, <sup>2</sup>Neurosurgery, Tohoku University Graduate School of Medicine, Sendai, Miyagi, Japan

**BACKGROUND:** Timing of the onset of subarachnoid hemorrhage (SAH) is important for treatment decision making, especially as some patients visit hospital several weeks after the onset of SAH. T2\*-weighted (T2\*W) magnetic resonance (MR) imaging is regarded as a sensitive method for the detection of deoxyhemoglobin or hemosiderin deposits.

**OBJECTIVE:** This study investigated the characteristics of the abnormal low intensity changes on T2\*W imaging in patients with SAH, how long the abnormal low intensity persisted, and whether the day of onset could be predicted based on the T2\*W imaging changes.

**METHODS:** This study included patients treated for SAH associated with ruptured cerebral aneurysms, or had previously suffered such SAH and were followed up at our hospital, between 2006 and 2007. All patients underwent gradient recalled echo (GRE) and echo planar (EP) T2\*W imaging. The low intensity change was classified into 5 grades on GRE and EP T2\*W images, to calculate the T2\* Score defined in this study.

**RESULTS:** A total of 50 patients with 74 MR images were included during the study period. Abnormal low intensity on T2\*W imaging was observed in all patients. The T2\* Score gradually decreased from the onset of SAH until day 90, showing a significant negative linear correlation ( $R^2 = 0.25$ ,  $p = 0.0002$ ). On the other hand, the T2\* Score did not change after one year.

**CONCLUSION:** The abnormal low intensity on T2\*W imaging gradually decreased until 90 days from the onset of SAH, but persisted 16 years after the onset. We could predict the day of onset with pure error  $\pm 10$  days in patients with SAH within 90 days of onset, using our grading system for T2\*W images.

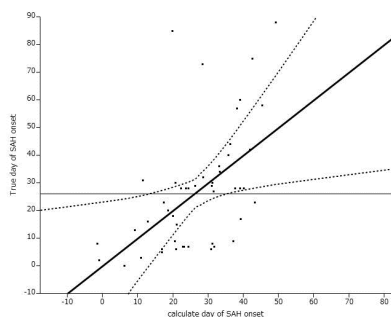
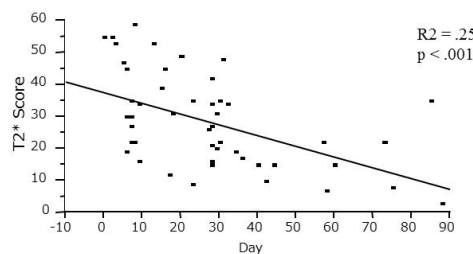
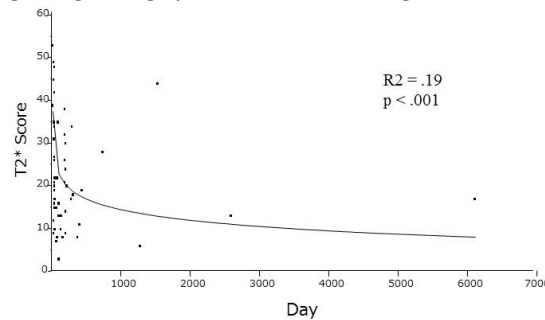
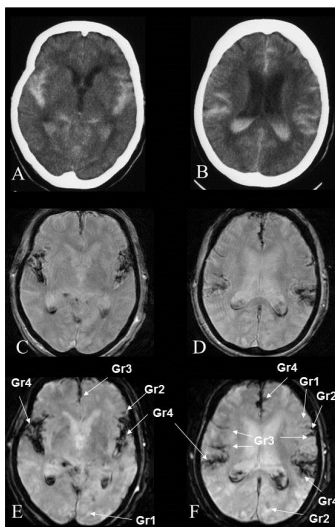


Figure 1: Classification of abnormal low intensity on T2\*W images into 5 grades. Grade 0, no abnormal low intensity on both GRE and EP T2\*W images; Grade 1, no abnormal intensity on GRE T2\*W images and low intensity on EP T2\*W images; Grade 2, spotty abnormal low intensity on both GRE and EP T2\*W images; Grade 3, medium abnormal low intensity (<5 mm) on both GRE and EP T2\*W images; and Grade 4, large abnormal low intensity ( $\geq 5$  mm) on both GRE and EP T2\*W images. Representative CT scans (A, B), GRE T2\*W images (C, D), and EP T2\*W images (E, F) are shown.

Figure 2: Relationships between day from the onset of SAH and T2\* Score. *Upper:* Significant negative logarithmic correlation is observed between the day from the onset of SAH and the T2\* Score in all periods ( $R^2 = 0.19$ ,  $p < 0.0001$ ). *Lower:* The T2\* Score gradually decreases from the onset of SAH until day 90, with a significant negative linear correlation between these parameters in this period ( $R^2 = 0.25$ ,  $p = 0.0002$ ).

Figure 3: Results of multiple regression analysis showing the recorded and calculated days from the onset of SAH. The correlation is significant ( $p = 0.0107$ ). Regression line (**bold line**), mean line (*fine line*), and two sided 95% confidence interval (*dotted line*).