**Evaluation of three ischemic signs and ischemic extent by T2*-weighted 3-Tesla MRI**

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**Introduction:** We reported the three ischemic findings on gradient echo-type T2*-weighted images (T2*-WI) by 3T MRI in patients with acute ischemic stroke Ref1). These were 1) cortical vessel sign (hypointensity and enlargement of the cortical vessels), 2) brush sign (hypointensity of the deep white matter vessels), and 3) ischemic tissue sign (decreased intensity in the ischemic parenchyma). In this study, the evaluation of these signs was conducted by grading into four classes to determine presence or absence of the signs, and the consistency of individual observations were assessed by kappa statistics. In addition, the quantified map of susceptibility effect was generated and compared to the T2*-WI and perfusion imaging. The purpose of this study is to evaluate whether the ischemic signs by T2*-WI have possibility to become a method beyond perfusion study or not.

**Methods:** The subjects were 24 patients with cerebral ischemic events (17 patients within 3 hours from onset, 7 within 12 hours). The gradient echo type T2*-WI and spin echo type T2-WI with double echo were obtained. The grading of visual estimation for three ischemic signs was conducted as following: 1) definitely present (remarkable asymmetry) 2) likely present (recognized asymmetry) 3) equivocal (obscure asymmetry) 4) likely not present (no asymmetry). After the individual judgment by two observers, the consistency was evaluated by kappa statistics. The quantified map of the susceptibility effect was made following the equation after the correction of distortion in gradient echo imaging: \(1/T2^*=1/T2^+T2\). The T2 map and the perfusion images with FAIR technique were generated. The asymmetry ratio between the ischemic and opposite sides was calculated on T2 map, T2*-WI and perfusion image. The instrument of MRI was a Sigma 3T HD (GE, Milwaukee, US) with a standard QD type headcoil.

**Results:** The consistency by two observers’ estimation was summarized in Table 1. The positive rate of ischemic tissue sign was lower than those of the other signs, but all of kappa values of three signs showed more than 0.70, indicating good consistency confirmed by statistical threshold (p<0.05). The positive cases of ischemic tissue sign revealed more hypoperfusion than that of the negative cases (Fig. 1). A typical case of T2 map and PWI with the occlusion of internal carotid artery showed in Fig. 2. T2 map showed smaller hypointense area than the hypoperfusion area, but larger than diffusion abnormality. Figure 3 showed the relation between the decrease rates of T2 and perfusion. The decrease rate of T2 value was less than that of perfusion, but the high correlation (r2=0.77) was found between T2 and T2 asymmetry ratios.

**Conclusion:** The observer’s bias would be small and it suggests these findings can be used with acceptable consistency as clinical indices. The T2 map would indicate increase of the susceptibility effect by deoxyhemoglobin and the high correlation of asymmetry ratio might show that T2*-WI reflects the density of deoxyhemoglobin in superacute phase, because T1 and T2 changes have not still occurred remarkably. T2*-WI would be used as a clinical method to evaluate ischemic extent.

![Table 1: Kappa analysis of the grading for the three ischemic signs by two observers.](image1)

(a)DWI (b)T2 map (c)PWI(FAIR)

![Fig. 2 A case of severe stenosis of left internal carotid artery](image2)

Ref 1)N Morita et al. Cerebrovasc Dis. 2008

![Fig. 3 Comparison of asymmetry ratios between T2 map and perfusion](image3)

![Fig. 4 Correlation between T2 and T2 asymmetry ratios](image4)