Study of pH-sensitive magnetization transfer imaging in hyperacute brain infarction using a clinical 1.5 Tesla scanner

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Introduction: When cerebral nervous tissue lacks of blood and oxygen, neurocyte is altered in metabolism, following with intracellular acid-base disturbance. Alteration of intracellular pH value can influence the magnetization transfer ratio[1-3] (MTR). So pH-sensitive magnetization transfer imaging (MTI) can reflect the alteration in metabolism[4]. Using this technology to image ischemic brain may make an early detection and prediction of ischemic penumbra.

Materials and Methods: Twelve male cats (weighted 2.4 ~ 2.8kg) were prepared for the middle cerebral artery occlusion (MCAO). All cats were scanned with a GE 1.5T MR scanner using a head-neck coil for radiofrequency transmission and an eight-channel sensitivity-encoding coil for reception. The sequences performed for each cat included T_1-weighted, T_2-weighted, and DWI. MTI readout was spin-echo imaging (slice thickness = 3 mm, slice spacing = 3 mm, TR = 400 ms, TE = 9 ms). MT was applied before image readout, with an offset frequency at 3.5 ppm (i.e. 224 Hz at 1.5T). All the images were acquired in the hyperacute infarct stage, within 3 hour after the MCAO.

Results and Discussion: We found that in 5 of 12 animals, there was no any alteration on the DWI, but on the MTI it displayed dark region in the occlusion side. In figure 1, the lesion is in the parietal and temporal lobe of left hemisphere. Select 0.1 cm² region as ROI in the lesion area and also in the corresponding contralateral (non-lesion) area. The mean signal intensity in the ROI is 510.6 (left) and 756.2 (right) separately. The signal intensity in the lesion area is lower than that in the corresponding contralateral side. The range of the lesion is sharper. In the other 7 of 12 animals we could observe hyperintensity region in the occlusion side on DWI, and observe the alteration on MTI (see in figure 2). The darkest part on the MTI corresponded to the lightest part in the DWI. In addition, comparing the range of the lesion in MTI vs DWI, we found that the lesion boundary displayed on the MTI is wider than that on DWI (Figure 3), pH sensitive MTI can more closely approximate the area of penumbra. Therefore, MTI is a good diagnostic approach for stroke or even TIA patients, and helps to select optimum treatment protocols.

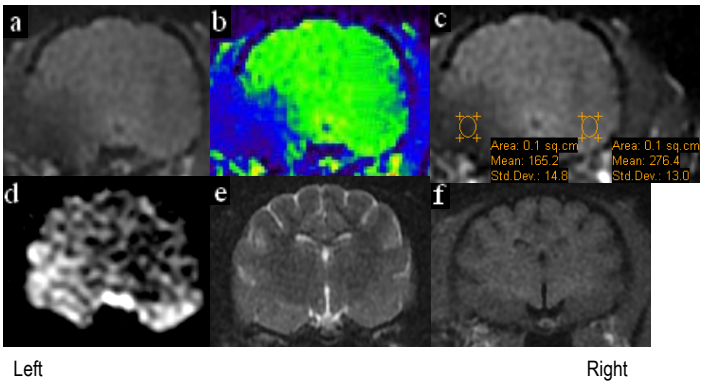

Figure 1. The lesion is in the parietal and temporal lobe of left hemisphere (a) MTI. A dark region is visible in the left side (b) MTI in color. The lesion area is displayed in blue color. (c) 0.1 cm² ROI are acquired in the lesion area and contralateral corresponding area. The mean signal intensity is 510.6 and 756.2 separately. (d) DWI. (e) T2WI. (f) T1WI

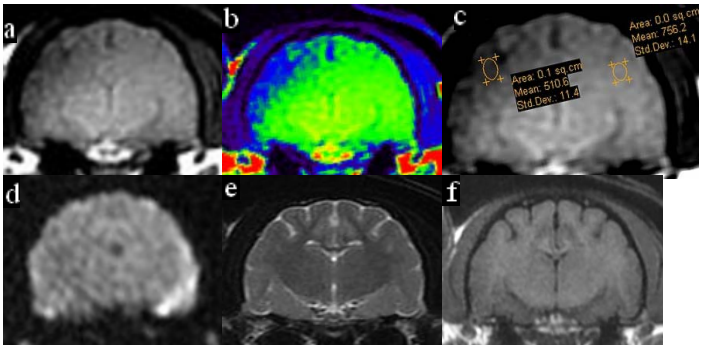

Figure 2. The lesion is in the temporal lobe of left hemisphere. (a) MTI. (b) MTI in color. (c) 0.1 cm² ROI are acquired in both sides. The mean signal intensity is 165.2 in the lesion area and 276.4 in the corresponding contralateral side. (d) DWI. (e) T2WI. (f) T1WI.

Conclusions: In this study, we could identify cerebral infarct lesions within 3 hours following MCAO, using MT with a 1.5T scanner. pH sensitive MTI is more sensitive to detect infarct than DWI during the hyperacute infarct stage.

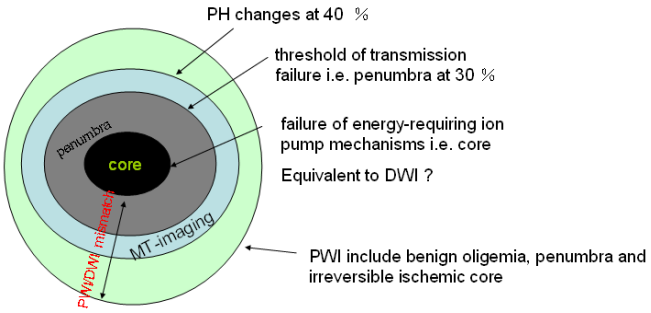

Figure 3. Compare MT-imaging with DWI and PWI. The boundary of lesion on MT-imaging more closely approximates the penumbra.

References: 1) Zhou et al. Nat Med. 2003; 9(8):1085-90. 2) Stephan et al. Neuroradiology. 2010; 52(3):189-201. 3) Sun et al. Magn Reson Med. 2011; 65(2):588-594. 4) Dario et al. Magn Reson Med 2011;65:202-211