Is PWI-DWI Mismatch Region Equal to Ischemic Penumbra: Experimental Study in Monkey Middle Cerebral Artery Occlusion (MCAO) Model

S. ZhiHua[1], Z. XueJun[1], and Z. YunTing[1]

[1]Radiology, General Hospital, Tianjin, Tianjin, China, People's Republic of

The mismatch region between MR DWI and PWI has been thought of as the reversible tissue, i.e. ischemic penumbra (IP). But the parameters of PWI have been confirmed not as exact as those of CT perfusion, such as cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT). So whether DWI-PWI mismatch regions were actual IP has been argued.

Purpose

Our purpose is to determine whether PWI-DWI mismatch region is proper to represent IP.

Materials and Methods

Seven male monkeys (Macaca Mulatta) were supplied by Experimental Animal Center of Beijin Military Medical Academy in China, with 5~7 years of age (mean 6.18 years) and 6~8kg of weight (mean 7.23kg). Middle cerebral artery occlusion (MCAO) model was performed by autothrombus interventional methods.

CT perfusion, DWI and PWI were performed at 1h, 5h, 10h, 15h, 20h and 24h after MCAO respectively. CT perfusion examination was performed with GE LightSpeed pro 16 CT scanner. MR imaging was performed with GE 1.5T Twin Speed Infinity with Excite I magnetic resonance system. Head coil was used, with a slice thickness of 4mm, a gap of 0mm, field of view (FOV) of 18cm×18cm, matrix of 288×256.

Select the slice of lateral ventricle body. Measure abnormal signal intensity area of different parameter maps at each time. To avoid individual error, calculate the ratio of measured area and the infarct area on T_2WI at 24h.

Results

The ischemic area grew progressively in all the parameter maps but MTT map (Fig.1). The evolution of area ratio at each time (Fig.2) was: at 1h and 5h, MTT>T2WI>DWI≈ADC≈DCavg>CBF>CBV≈NEI; at 10h, MTT>T2WI>CBF>DWI≈ADC≈DCavg>CBV≈NEI,; during 15h to 24h, MTT>CBF>T2WI≈DWI≈ADC≈DCavg>CBV≈NEI.

The abnormal area on DWI increased within 10h after attack. So we proposed that in the early stage of ischemia IP was present in the high signal intensity on DWI, which leaded that DWI-PWI mismatch region would underestimate exact IP. At 24h, the areas of CBF or MTT maps were larger than that of CBV map, suggesting this mismatch region probably represented benign oligemia. So we concluded that DWI-PWI mismatch region could not represented IP exactly, but MTT-DWI mismatch region may be more proper.

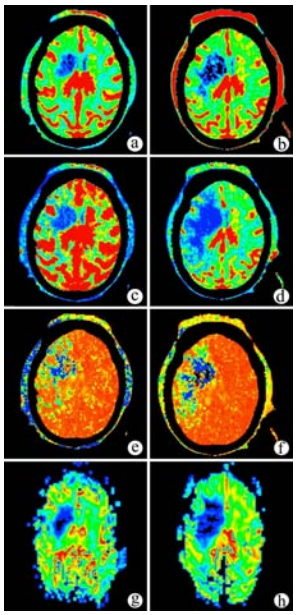
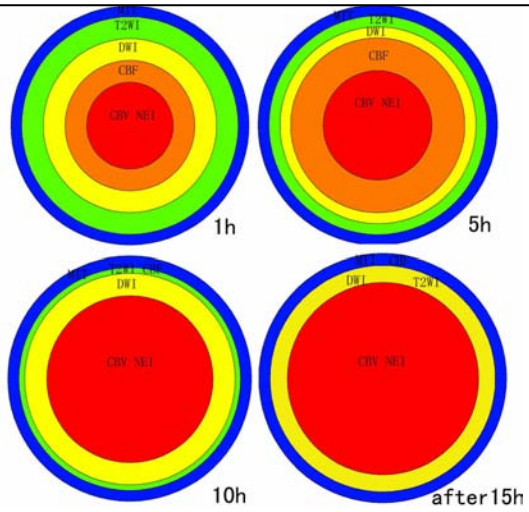


Fig.1 CBV, CBF, MTT and NEI maps at 1h and 24h. Ischemic areas enlarged on CBV, CBF and MTT, except on MTT

Fig.2. The pattern map of area evolution by different parameters of monkey MCAO model



Conclusion

In the early time of infarction IP was present in the region with high signal intensity on DWI. PWI-DWI mismatch regions could not estimate IP areas actually. CT perfusion (MTT) and DWI mismatch regions were much more close to the actual IP.