Comparison of Two Methods of Assessment of Perfusion-Diffusion Mismatch in a Rodent Model of Ischemic Stroke

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Background and Purpose

Fundamental controversies exist in identifying a mismatch between perfusion-weighted imaging (PWI) and diffusion-weighted imaging (DWI), e.g., the lack of consensus regarding what constitutes the pair of mismatch and which PWI-derived parameter best defines the hypoperfused region. The PWI-DWI mismatch is strictly time dependent, and the moment to acquire PWI is particularly critical in clinic. This study is to define the mismatch between PWI and DWI in magnetic resonance imaging (MRI) by applying early or instantly acquired PWI.

Methods

Eight rats were induced with stroke through photothrombotic occlusion of the middle cerebral artery (MCA) and scanned serially from 1h to 72h using DWI and PWI with a 1.5 T MR scanner. The relative lesion volume (rLV) on MRI and triphenyl tetrazolium chloride (TTC) stained specimens were defined as the proportion of lesion volume over brain volume. Discrepancies of the rLV between PWI and DWI were expressed by the subtraction of apparent diffusion coefficient (ADC) from PWI, resulting in three possible patterns: 1) [PWI-ADC > 10% of PWI] denoting a mismatch; 2) [-(10% of PWI) ≤ PWI-ADC ≤ 10% of PWI] denoting a match and 3) [PWI-ADC < -(10% of PWI)] denoting a reverse mismatch. The differences were compared with the minuend being either early PWI (ePWI) or instant PWI (iPWI) and the subtrahend being instant ADC (iADC). The occurrence and evolution of PWI-ADC patterns were analyzed.

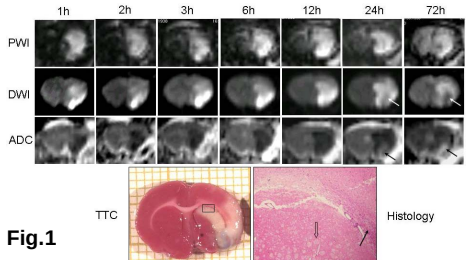

Fig.1

Figure 1 Evolution of cerebral ischemia on MR. PWI source image reveals a hyperintense ischemic lesion larger than that on ADC map within 12 h followed by a volume reduction after 24h, indicating the late restored blood perfusion. Histology focusing approximately on the rectangle at TTC stained specimen shows severe necrosis with extensive vacuolation and tissue disintegration (blank arrow). A rim of neutrophil infiltration is found at the margin of infarcted area (arrow).

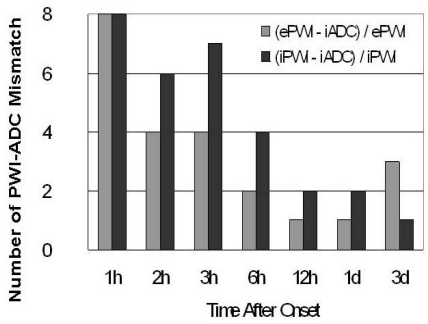

Fig. 3

Figure 3. The occurrence of mismatch pattern in both ePWI-iADC and iPWI-iADC models during 1h to 72h after MCA occlusion.

Figure 2 The rLVs of PWI-DWI evolve from a mismatch pattern (PWI>DWI) into a match pattern (PWI≈DWI) and reverse mismatch pattern (PWI<DWI) with time.

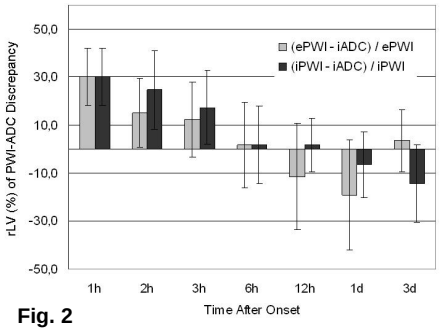

Fig. 2

Results

Over time the PWI-ADC discrepancies evolved from mismatch, through match, to reversed mismatch (Fig.1). The PWI-ADC mismatch still existed 72h after MCA occlusion in 12.5-37.5 % of cases. The rLVs and mismatch incidences between ePWI-iADC and iPWI-iADC models were linear-correlated (r2=0.781, p = 0.038) (Fig.2). A higher mismatch rate tended to occur in iPWI-iADC within 24h and in ePWI-iADC at 72h (Fig.3).

Conclusions

Both ePWI and iPWI proved to be useful to define PWI-DWI patterns within 24h. iPWI appeared more adequate due to the time-dependent alterations in stroke at 72h,.

References

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