

Acute Stroke Triage & Management: Radiological Perspective

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A number of different MRI techniques are used in the diagnosis of stroke.

The imaging regimen in acute stroke includes diffusion weighted imaging (DWI), T2 and fluid attenuated inversion recovery (FLAIR) weighted imaging, gradient recalled echo imaging (GRE) or susceptibility-weighted imaging (SWI) and magnetic resonance angiography (MRA), followed by physiological assessment with perfusion weighted imaging (PWI). (Wintermark et al., 2008) Stroke evaluation protocols should include a combination of DWI and PWI, because together they define the location and extent of ischemia and infarction within minutes of onset. In addition, when performed in series, they can provide information about the pattern of evolution of the ischemic lesion and treatment monitoring. (Duong and Fisher, 2004)

Perfusion imaging can play an important role in identifying haemodynamic insufficiency and in grading its severity, and can be readily integrated into neuroimaging protocols. (Essig et al., 2013) Contrast-based PWI, also known as dynamic susceptibility contrast magnetic resonance perfusion (DSC-MRP) is based on a magnetic susceptibility contrast phenomenon involving T2 and T2*-effects of intravenous (iv) bolus-injected contrast agents. Images are acquired by serial imaging of the whole brain as a bolus of gadolinium-based contrast agent (GBCA) passes through the tissue capillary bed. From these images it is possible to calculate functional parameters such as relative cerebral blood flow (rCBF), relative cerebral blood volume (rCBV), and transit parameters including the mean transit time (MTT), time-to-maximum (Tmax) and time-to-peak (TTP) maps.

Complete interruption of blood flow in acute stroke results in irreversible injury within minutes. (Counsell et al., 2004) In many cases, however, vascular occlusion by atherosclerotic plaques develops over time, which allows the development of a collateral blood supply to the affected tissues and this can sustain brain tissue for hours after the occlusion of major arteries to the brain. Cerebral tissue that is viable but at risk for infarction, the ischemic penumbra, can be saved if appropriate intervention is promptly initiated. (Duong and Fisher, 2004) The viability of this region may extend to 48 hours after the onset of stroke. Even in acute stroke, PWI can capture and characterize blood flow changes in the critical hours after symptom onset, allowing the opportunity to assess the ischemic penumbra and to intervene. Determining the volume of the ischemic penumbra helps to identify patients who would benefit from thrombolytic therapy or conventional treatments, such as carotid endarterectomy or blood pressure elevation.

The diffusion-perfusion mismatch, i.e. the difference in size between lesions captured by DWI and PWI, may also be used to assess the ischemic penumbra and is a strong predictor of lesion volume growth. It can measure the tissue at risk and has been increasingly used in the evaluation of hyperacute and acute stroke. (Chen and Ni, 2012; Warach, 2003) Two clinical trials involving acute ischemic stroke patients, (DEFUSE (n=74), and EPITHET (n=101), have established that a mismatch between PWI and DWI imaging volumes may be used to select patients for reperfusion treatment (Figure 2). (Lansberg et al., 2011; Lansberg et al., 2007; Nagakane et al., 2011)

Infarct core is assessed by DWI, which has been found to have substantially better sensitivity and accuracy than CT in the assessment of hyperacute ischemia.(Fiebach et al., 2002; Saur et al., 2003). It is widely accepted that lesions with diffusion slowing represent tissues prone to infarction. After acute stroke, damage to the blood-brain barrier occurs(de Vries et al., 1997) and allows leakage of contrast agent into cells from the extracellular space. However, increased use of DWI in acute stroke has revealed that lesions that initially show diffusion slowing may undergo diffusion normalization. It has therefore been concluded that acute slowing of diffusion is not necessarily an indicator of infarct.(Fiehler et al., 2004)

There is a need for a consensus on which perfusion measurement and processing methods should be routinely used in clinical practice.(Kane et al., 2007; Leiva-Salinas et al., 2011) DSC-MRP in combination with DWI is most commonly used in the evaluation of acute stroke and transient ischemic attacks.(Ostergaard, 2005; Schaefer et al., 2000; Siemund et al., 2009)