Better Late than Never

The Long Journey for Noncontrast Arterial Spin Labeling Perfusion Imaging in Acute Stroke

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This report describes the authors’ experience using a noncontrast brain perfusion method, arterial spin labeling (ASL), in patients with acute ischemic stroke and compares this with dynamic susceptibility contrast MRI. This latter technique is also sometimes referred to simply as perfusion-weighted imaging (PWI) to emphasize its complementary nature to diffusion-weighted imaging. The authors found excellent overlap between imaging information available with PWI and ASL with no measurable difference in perceived signal-to-noise ratio or lesion conspicuity. They also found that the effects of slow flow on the ASL signal, although present, were not an insurmountable impediment to image interpretation in that they correlated with the changes seen in the PWI time-to-maximum of the residue function (T_{max}) and the nondelay-corrected cerebral blood flow maps. In particular, they point out that the parenchymal microvascular contrast afforded by the ASL images was particularly useful in visualizing hyperemia related to reperfusion, sometimes termed luxury perfusion.

The basic ASL and PWI techniques were initially described >20 years ago, and both were applied to human patients with stroke relatively soon thereafter. PWI has become a mainstay of academic medical center MR stroke examinations. The dominant paradigm in the stroke imaging community is the PWI–diffusion-weighted imaging mismatch, which posits that patients with large perfusion lesions but small diffusion lesions have potentially salvageable tissue that can be “rescued” by prompt recanalization. ASL, despite the advantage of being a noncontrast perfusion technique, has not enjoyed widespread clinical use; however, because of 2 factors: first, the generally lower signal-to-noise ratio of the images; and second, the strong dependence of the ASL signal on delayed arterial transit times between the site of labeling and imaging. The first of these concerns is becoming alleviated with the adoption of higher field MR scanners and improved ASL pulse sequences that use pseudocontinuous labeling, background suppression, and optimized image readout. The second issue is more fundamental. Because the labeled water decays with the blood T1 time, which is on the order of 1 to 2 seconds, flow that arrives late, perhaps through collateral pathways, may be incorrectly interpreted as absence of flow. This is a critical distinction in acute ischemic stroke, in which collateral flow has been shown to be a key factor in patient outcome. Although current methods appear to yield information about collaterals, newer techniques such as velocity-selective ASL, which labels blood based on velocity rather than by position, and is theoretically insensitive to arrival time, will hopefully mitigate this issue. Finally, the recognition of the association between gadolinium contrast agents and nephrogenic systemic fibrosis has made bolus PWI a contraindication in some patients with stroke, making a noncontrast stroke protocol using ASL more clinically desirable because it eliminates the need to determine creatinine clearance before MR scanning.

More MR vendors are developing product sequences and clinicians are gaining more experience with ASL in stroke. Because standard ASL does not typically yield information about arterial arrival times, future studies must determine the relationship between cerebral blood flow measures and T_{max} regarding mismatch status and patient outcome. Another important focus will be the development of automated methods to assess lesion size, which is challenging for ASL due to the inherent cerebral blood flow differences between gray and white matter. Studies (such as this one) using both ASL and PWI, at least in the short term, will likely provide unique insights into the pathophysiology of the hemodynamic state in patients with acute stroke.

Disclosures

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References


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