Arterial spin labelling in routine clinical practice

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Introduction:
Arterial Spin Labelling (ASL) is an MRI sequence to evaluate cerebral blood flow, without the need for intravenous contrast. Although first described almost 20 years ago, the sequence has been slow to be adopted into clinical practice. This is a pictorial review of ASL in a routine hospital based clinical practice, using a basic ASL sequence supplied by Siemens on a 3 tesla Siemens Trio MRI scanner with a 32 channel head coil. We have used the sequence to assess tumour grade in imaging of gliomas (Figure 1), stroke imaging (Figure 2), hyperperfusion syndrome post-endarterectomy (Figure 3), epilepsy (Figures 4 and 5), dementia and migraine. We also demonstrate a number of artefacts that are unique to ASL and that are important to recognise and not mistake for pathology.

Methods:
A pulsed arterial spin labelling sequence was used at 3 tesla with a 32 channel head coil, 64X64 matrix, 256mm FOV, 8 mm slice thickness, 9 slices , 2500 ms TR, 11 ms TE and 4 minute 5 second acquisition time.

Results

ASL for grading tumours.
ASL provides a quantitative measurement of cerebral blood flow which can be used to assess for the angiogenesis seen in high grade gliomas. Studies have shown a good correlation between ASL and the more commonly used DSC perfusion techniques in assessing cerebral blood flow in gliomas. The cerebral blood flow maps from DSC are generally higher resolution and better signal to noise but both studies reveal the same diagnostic information, demonstrating increased cerebral blood flow within higher grade tumours.

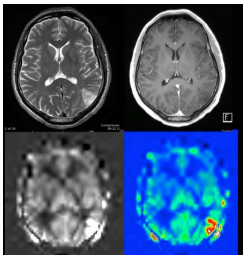
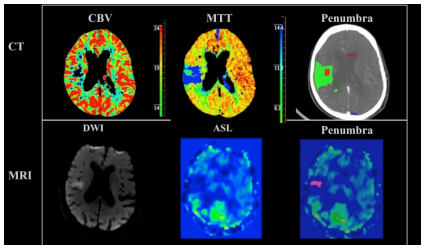


Figure 1. A. T2 and contrast enhanced T1 weighted images showing non-enhancing glioma within the left parietal lobe. B. ASL study demonstrates increased CBF within the tumour.

ASL in stroke imaging
ASL is a useful sequence as part of a rapid imaging protocol for acute stroke. Along with diffusion weighted imaging (DWI), the core infarct and ischaemic penumbra can be accurately delineated without the need for intravenous contrast agents. Figure 2 demonstrates a small acute infarct within the right MCA territory demonstrated on CT by reduced cerebal blood volume (CBV), surrounded by an iscahemic penumbra of increased mean transit time (MTT). The MRI study delineates the core infarct more accurately with DWI and shows the ischaemic penumbra as reduced CBF using ASL without intravenous contrast.

Figure 2. DWI combined with ASL provides accurate depiction of the core infarct (DWI) and the surrounding ischaemic penumbra (ASL) without the need for intravenous contrast as required for CT perfusion imaging.



ASL in hyperperfusion
Hyperperfusion can occur post endarterectomy due to a loss of auto-regulation by the cerebral vessels. Figure 3 demonstrates an example of hyperperfusion in an 82 y.o. lady who had undergone a left carotid endarterectomy 7 days previously and presented with new onset aphasia and right arm weakness. Increased cerebral blood flow is shown in the left cerebral hemisphere on both DSC and ASL studies. Possibly because of the low signal to noise of ASL images, hyperperfusion seems more prominent on the ASL study compared to DSC images.

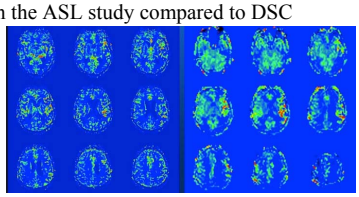


Figure 3. DSC study on the left showing hyperperfusion in left cerebral hemisphere 1 week post carotid endarterectomy. ASL study on the right also demonstrating hyperperfusion within the left cerebral hemisphere.

ASL in epilepsy
ASL is a useful sequence to add to the epilepsy protocol as it can demonstrate the site of the epileptogenic focus, either with reduced perfusion interictally or, occasionally as increased perfusion if scanned ictally (Figures 4 and 5).

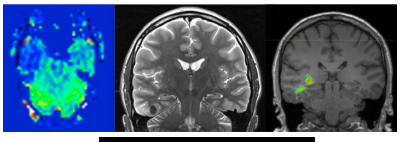


Figure 4. Left. Interictal ASL study showing reduced CBF in right temporal lobe of patient with right temporal lobe epilepsy. Middle. Coronal T2 image showing cavernous haemangioma in right temporal lobe. Right. Fibre tracking demonstrating Meyer's loop passing adjacent to the haemangioma

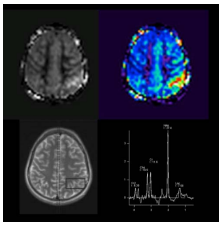


Figure 5. A. ASL image showing marked focal increase in CBF within the left parietal lobe of patient with poorly controlled seizures, indicating recent or ongoing seizure activity. B. Colour map of ASL study. C. T2 weighted image does not demonstrate any structural or signal abnormality in the region of increased CBF. D. MR spectroscopy of the region of interest from C demonstrates a raised lactate peak consistent with recent seizure activity.