A COMPARATIVE STUDY OF DYNAMIC SUSCEPTIBILITY CONTRAST AND ARTERIAL SPIN LABELING IN CHILDHOOD BRAIN TUMOURS.

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Target audience: Clinicians and MR researchers interested in ASL and DSC applications in the brain.

Purpose: Dynamic susceptibility contrast (DSC) imaging is used in clinical practice to obtain quantitative measures of tumour perfusion, to differentiate tumour type and monitor response to treatment [1]. The use of contrast agents limits its use in children to only essential diagnostic cases and prevents longitudinal measures over a short period. Arterial spin labelling (ASL), however can noninvasively measure perfusion by manipulating the inflowing spins of blood water to behave as an endogenous tracer. ASL may also be more accurate in the presence of breakdown of the blood-brain barrier (as the tracer is freely diffusible), and large vessel artefacts can be reduced through the use of vascular crushing [2]. Recently, the development of the Look-Locker readout ASL sequence (LL-ASL) [3] allows for efficient multi timepoint capture of the ASL signal, allowing the estimation of bolus arrival time as well as perfusion. This study aims to compare measures from clinically used sequences for DSC, the LL-ASL without (noVC-LL-ASL) and with vascular crusher (VC-LL-ASL) within children with brain tumours. This comparison will help establish the feasibility of using ASL for the assessment of tumour perfusion in clinical practice.

Method: DSC and the Look-locker ASL with and without vascular crushers were part of a clinical protocol currently in use at Alder Hey Children's Hospital. Data from 8 patients aged (11.5±4.2 years) who had previously been diagnosed with brain tumours were scanned. All 8 patients were scanned with the DSC and noVC-LL-ASL sequences; whilst only 6 had the additional VC- LL-ASL scan. All scans were carried out on a 3T Philips Achieva scanner. **DSC** scans were carried out using a GRE-EPI sequence (TR: 1694 ms; TE: 40 ms; FA:75 deg; Slice thickness: 4mm; 1.75x1.75 voxel sizes). DSC data was acquired for 2 minutes following a Gadolinium (Dotarem,Guerbet Lab Ltd) bolus injection of 1ml followed by 0.1mmol/kg by pump iv injection 2-3 ml/sec. **ASL** Look-Locker EPI readout data was acquired with STAR labelling and 8 readout times from 300 to 2050 ms with a step size of 250msec with the following parameters (TR:4000 ms; 3x3x6.6mm voxels; 9 slices; FA:40 deg; TE:12 ms (without vascular crusher)/ TE:20 ms (with vascular crusher)).DSC data was analysed using a commercial software MIStar (Apollo Medical Imaging Technology). An AIF was chosen from a large artery close to the tumour region and the DSC data was modelled as outlined by [4] to produce quantitative maps for MTT, rCBF and delay time. ASL data was analysed using in house MATLAB routines using a single blood compartment model [5] adapted for LL readout [6] to produce maps of CBF and arrival time (tA). Mean values for DSC and ASL perfusion metrics were estimated within a cylindrical region encompassing the tumour using ImageJ (rsb.info.nih.gov).

Results:

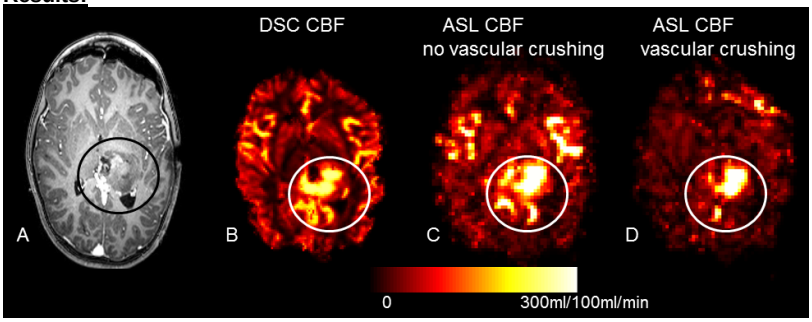

Figure 1: CBF maps from a single subject showing the tumour (within the circle) on a T1-weighted image (A), a DSC rCBF image (B) and the ASL CBF image without (C) and with (D) vascular crushers. It can be seen that in both the DSC (B) and noVC- LL- ASL (C) images, larger arteries dominate the signal especially around the tumours, whereas large artery signals are considerably reduced with the VC-LL-ASL image (D) and the tumour region is easier to distinguish.

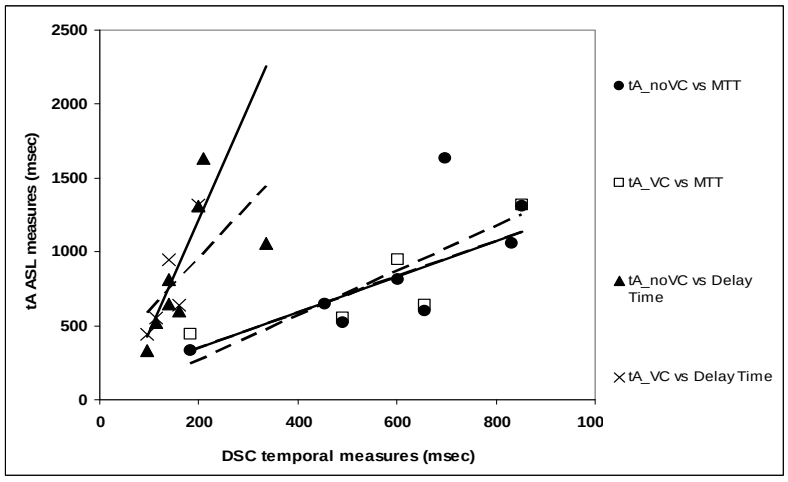

Figure 2: Plot showing arrival time measures from ASL with (VC) and without (noVC) vascular crushers against DSC timing parameters of MTT and delay time. High levels of correlations were found for tA_noVC vs MTT (r^2=0.57,p=0.03); tA_noVC vs delay time (r^2=0.38,p=0.1); tA_VC vs MTT (r^2=0.71,p=0.08) and tA_VC vs delay time (r^2=0.76,p=0.06).

Discussion: There was a good correlation between measures from DSC and both LL-ASL techniques for perfusion. Interestingly, high correlations were found between the temporal measures of the two techniques suggesting that arrival time measures derived from LL-ASL method could provide comparable information to MTT and delay time using DSC. Perfusion measured with the non-vascular crusher LL-ASL data was closer in magnitude to the DSC measures than the vascular crushed data as these two techniques both include signal from larger arteries (see Figure 1),. Encouragingly, perfusion maps from the non vascular crusher LL-ASL technique seems to suggest removal of the larger artery signals allow for clearer recognition of the diseased tissue (Figure 1).

Conclusion: This study is a promising first step towards the possible application of ASL to measure parameters generally derived from DSC techniques in a clinical cohort.

References: **[1]** Law, M., et al.,American Journal of Neuroradiology, 2004. 25(5); **[2]** Calamante, F., et al.,Journal of Cerebral Blood Flow and Metabolism, 1999. 19(7); **[3]** Gunther, M., M. Bock, and L.R. Schad, Magnetic Resonance in Medicine, 2001. 46(5): **[4]** Ostergaard, L., et al., Magnetic Resonance in Medicine, 1996. 36(5):**[5]** Parkes, L.M. and P.S. Tofts, Magnetic Resonance in Medicine, 2002. **48**(1): **[6]** Parkes,L., et al., ISMRM Annual Meeting 2012.