Feasibility of arterial spin labeling in the measurement of breast perfusion

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Introduction

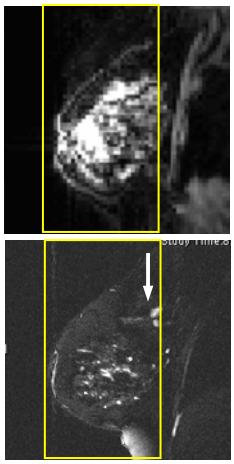
Breast cancer is the second leading cause of cancer deaths in women today (1). T1-weighted dynamic contract-enhanced (DCE) MRI has shown its potential in providing an indication of breast perfusion and permeability and whereby improves sensitivity and specificity in the diagnosis and prognosis of breast cancer (2,3). However, absolute quantification of perfusion/permeability still remains challenging in DCE-MRI which limits its use in longitudinal studies to follow therapeutic effects. A small proportion of patients are not suitable for the administration of gadolinium chelates due to potential nephrotoxicity. Arterial spin labeling (ASL) is a completely noninvasive MR method for perfusion quantification by utilizing magnetically labeled water molecules in arterial blood as an endogenous tracer. Primarily applied for functional brain studies, the application of ASL in organs with low baseline blood flow, such as breast and skeletal muscle, has been hampered by the intrinsically low SNR. Here we show, for the first time, that ASL can be used to image breast perfusion at baseline and its potential use in detecting cancerous tissue.

Materials and Methods

Three female patients (age range = 24-55 years) were included in this study and all gave written informed consent before participating. The patients were selected for MRI examination based on a finding of a palpable mass or mammographic or sonographic abnormality. Imaging was performed on a 1.5T Siemens Sonota system. T2-weighted images were first acquired to localize the lesion or suspicious area. Perfusion imaging was then performed with a pulsed ASL technique modified from FAIR (4). Seven 6mm thick sagittal slices were prescribed with an inter-slice gap of 1.5 mm. The selective inversion slab was placed in coronal orientation and the thickness was adjusted to cover the region of interest (breast parenchyma). The tagging slab covers the chest including the heart (which is visible on the sagittal images), thereby providing an ample volume of labeled blood. QUIPSS II (5) was used to generate a tag bolus of 700 ms. To inspect the arrival of blood flow, three transit times (TI = 1700, 1900 and 2100 ms) were applied in separate scans. Other imaging parameters included: TR/TE = 4000/25 ms, in-plane matrix size = 64x64, 80 acquisitions. A gradient-echo echo-planar readout was used for data collection.

Results and Discussion

The position of selective inversion is shown in Fig 1. Fig 2 shows ASL signals obtained from a patient diagnosed of a tumor in the right breast. The tagging region including the chest wall and heart shows signal enhancement due to the difference between slice-selective and non-selective inversions. In the target region, signal distribution shifts from vessels (localized high intensity) to tissues with increasing post-labeling delay time. The signal change (dM/M_0, in which dM is the signal difference between tag and control images and M_0 is the longitudinal magnetization of blood at thermal equilibrium) changes from 0.45% to 0.27% and 0.25% when the delay time is increased from 1700, 1900 and 2100ms (outlined in white, Fig 3). The arrow in Fig 1b indicates the position of lesion. Flow elevation is found in Fig 3. In summary, this pilot study demonstrates the feasibility of ASL in imaging breast perfusion. Although the baseline flow is low, the generally enhanced signal in cancerous tissue may provide an easy target for screening purpose. ASL may also be useful in longitudinal studies to follow the effect of therapy.



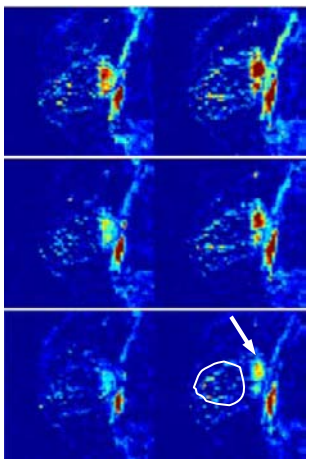


Fig 1. EPI image (a) and T2-weighted image (b). The arrow indicates the lesion.
Fig 2. Perfusion maps. From left to right: four slices. From top to bottom: transit time = 1700, 1900 and 2100 ms, respectively. Elevated flow can be seen at the lesion.

References

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4. Wang et al., MRM 2002;48:242-254. 5.Wong et al., MRM 1998;39:702-708.