JSMRM-KSMRM Joint Symposium (Neuroradiology)

SY12-1

High resolution MRI for intracranial artery: Technique and Application

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1. Technique

1) Basics: 3D, Multicontrast, Resolution of 0.4 ~ 0.7 mm3
2) Coverage: Most of intracranial arteries and carotid bulbs
3) TR: Around 1000 ms
4) Fast imaging: Compressed sensing and parallel imaging
5) Black blood: DANTE vs iMSDE vs T1 FLAIR

2. Application

1) Basics: Intracranial atherosclerosis and moyamoya disease
2) Dissection
3) Aneurysm (not for the vessel wall)

Keywords : High resolution, MR, Vessel wall, Techinque, Application

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SY12-2

Whole-brain Vessel Wall Imaging: Initial Clinical Experience

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Various techniques of high-resolution MR imaging have been introduced for the direct evaluation of intracranial arterial vessel walls. Among them, black-blood (BB) sequences are widely used including a T1-weighted BB turbo spin-echo (TSE) sequence and a single-shot fast spin-echo (SSFSE) sequence using a variable refocusing flip angle. In most previous investigations, because of the conflicting demands on long scan times, spatial coverage has been usually limited to a thin target volume determined a clinically suspected disease (e.g., M1 of the middle cerebral artery or the vertebrobasilar system) employing whether 2D or 3D data acquisition. As a result, lesions out of the target volume might have been missed. Meanwhile, recent studies reported whole-brain vessel wall imaging (VWI) using a cerebrospinal fluid-attenuated T1-weighted 3D TSE sequence or its modification (Fan Z, et al. and Yang Q, et al.).

In this presentation, technical aspects of sequences for whole-brain VWI that are similar to but are modified from the reported ones at my institution will be presented. In addition, a new method of BB MR angiography obtained by application of minimum intensity projection to data of such sequences will be introduced.

After showing technical aspects, our initial clinical experience of above-cited methods in the diagnosis of major artery stenoocclusive lesions, moyamoya disease and status post extracranial-intracranial (EC-IC) bypass as well as arteritis and similar lesions, arterial dissection, simultaneous demonstration of intracranial and cervical arteries and demonstration of the lenticulostriate arteries will be shown.

For major artery stenoocclusive lesions and arterial dissection, our methods of whole-brain VWI show an atherosclerotic plaque and dissection-related lesions including an intramural hematoma and an intimal flap comparably to VWI using conventional protocols. Our recent study on whole-brain VWI and its applied BB MR angiography in patients after EC-IC bypass for major artery stenoocclusive lesions and moyamoya diseases shows the techniques effectively reveal stenosis or occlusion and status of EC-IC bypass. Whole-brain VWI is advantageous in arteritis and similar lesions as it can depict lesions located in a distal part of major arteries. Similarly, thanks to the wide target volume, whole-brain VWI can demonstrate stenosis or occlusion of cervical artery along with the status of intracranial arteries in one session. Our experience also suggests that BB MR angiography is promising for visualizing the lenticulostriate arteries.

In summary, it is possible to perform whole-brain VWI that shows intracranial vessel lesions with good contrast in a reasonable scanning time. A new method of BB MR angiography generated from the method could be valuable to depict bypass vessels and perforating arteries.

Keywords : Intracranial vessel wall, MR imaging, Cerebral arteries, Vessel wall imaging

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SY12-3

DCE-MRI in the Neuroimaging: Current Challenges and Future Perspectives

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1. Technical principles of DCE-MRI

   - Basic principles of DCE-MRI
   - Imaging acquisition: T1 mapping, sequence, temporal resolution, total acquisition time
   - Imaging analysis: AIF, pharmacokinetic models

2. Clinical applications of DCE-MRI

   - Brain tumor

3. Challenges in DCE-MRI

   - Imaging acquisition: Pre-contrast T1 mapping, temporal resolution, total acquisition time, B1 inhomogeneity
   - Imaging analysis: Model selection, AIF, region of interest, motion correction, processing time

4. Future perspectives

   - DCE-MRI for low-level permeability lesion: Dementia, multiple sclerosis
   - DCE-MRI with high spatial resolution: vascular imaging, spinal cord imaging

Keywords : DCE-MRI

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IVIM Perfusion Imaging: Neuro Applications

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Intravoxel incoherent motion (IVIM) is a two-compartment diffusion model proposed by Le Bihan. This model assumes signal decays due to true diffusion and pseudo-diffusion that originates from capillary perfusion, and is described by coefficients of the true diffusion (D) and pseudo-diffusion (D*) as well as perfusion fraction (f). Particularly, the f, which is considered to be proportional to the tissue blood volume, has proven useful in non-contrast assessment of tissue perfusion. Recent studies have shown that IVIM imaging can be helpful in managing preoperative and postoperative glioma. The conventional IVIM imaging has several limitations. First, IVIM imaging sequence is usually based on echo planar imaging (EPI), which suffers from serious image degradation due to field inhomogeneity in the skull base. IVIM imaging based on non-EPI diffusion-weighted imaging can help evaluate skull base structures. We demonstrated the feasibility of IVIM assessment of the normal pituitary gland using turbo spin-echo based IVIM imaging (TSE-IVIM). Moreover, TSE-IVIM allowed for perfusion assessment of pituitary adenoma. Conventional IVIM model ignores difference in relaxivity and proton density of the two diffusion compartments, which may introduce biases in estimating IVIM parameters. We evaluated effects of T2 and proton density on calculated f using computer simulation, revealing that the conventional IVIM imaging substantially overestimates f in brain tissues, especially in white matter.

Keywords : Intravoxel Incoherent Motion, Perfusion

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SY12-5

Arterial Spin Labeling Perfusion Imaging: Can we say it is Quantitative?

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Arterial spin labeling (ASL) is an entirely noninvasive magnetic resonance (MR) perfusion assessment utilizing water in blood as an endogenous tracer that provides quantitative values of cerebral blood flow (CBF). This technique has been expected to give much new and important information beyond qualitative images and into quantitative images in the field of medical imaging. As the first MRI-based practical quantitative imaging in the clinical setting, ASL has been applied to various brain disorders, including brain tumors, vascular disease, degenerative disorders, and epileptic disorders. Among these central nervous system disorders, vascular diseases are direct targets for ASL perfusion, since the vascular system dose contains the labeled spins, allowing us to understand pathophysiological changes in diseases. In my presentation, first, we focus on common clinical applications, particularly in stroke, where ASL can be used to assess perfusion alterations in both the acute and chronic phase. In arteriovenous malformations, ASL is very sensitive for detecting shunted labeled signals from the arterial to the venous system, which may be used for assessment after irradiation therapy in follow-up MR examinations.

Although absolute CBF measurement is not always necessary in routine clinical settings, when a quantitative CBF value from ASL is preferred, a number of parameters need to be measured at the cost of extended scan time, such as physiological parameters including T1 of brain tissue, T1 of arterial blood, arterial blood volume, and arterial transit time (ATT). Among the parameters needed in absolute CBF calculations, consideration of ATT is the most crucial in measuring absolute CBF by ASL, especially in patients with occlusive cerebrovascular disease, where heterogeneously prolonged ATT due to the drop in perfusion pressure and consequent development of collateral pathways result in underestimation of regional CBF with single post-labeling delay (PLD) acquisition. The most straightforward approach is to acquire images with multiple PLDs consecutively. We present how the consideration of ATT affects measurement of ASL-CBF by comparing findings from PET-CBF in chronic occlusive CVD patients.

Lastly, we focus on other emerging applications of ASL-based techniques, which allow us to measure additional physiological parameters beyond perfusion. By adding vessel suppression (VS) to ASL acquisition in short PLD and using a sufficiently long labeled condition, if VS selectively disperses the signal from the vasculature but not from tissue, we can obtain pure extravascular perfusion images. In such cases, we could also obtain arterial blood volume-weighted images (aCBVs) by subtracting images with VS ASL from images without VS ASL. Moreover, we could calculate quantitative aCBV values using a two-compartment model consisting of microvasculature and other tissue with some appropriate parameter assumptions. Arterial blood volume is very sensitive to an altered hemodynamic state of perfusion and these images might provide the opportunity to describe early ischemic or misery states in chronic occlusive CVD or other disorders.

Keywords : ASL, CBF, CBV, Acute infarction, Occlusive CVD