ISC Symposium (Abdomen)

SY09-1

Past development of DWI in abdominal MRI

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Magnetic resonance (MR) imaging is now widely used for the evaluation of patients with abdominal pathologies, especially in liver, because of its redeeming features compared to computed tomography (CT) such as lack of ionizing radiation, high contrast resolution, and functional imaging sequences. With the development of a parallel encoding technique that has markedly improved image quality, diffusion-weighted MR imaging (DWI) can be applied to abdominal imaging and becomes established routine MR imaging protocol for the liver. Qualitative and quantitative assessment of tissue diffusivity based on diffusion signal and apparent diffusion coefficient (ADC), respectively, can provide supplementary information in diagnosing diffuse and focal liver diseases. This lecture looks back on past developments regarding acquisition parameters and post-processing technique, and introduces the uses of DWI serving as transition to the current DWI status, for focal liver lesion detection, characterization, tumor treatment response, and diagnosis of diffuse liver diseases.

Keywords : Diffusion, IVIM, Kurtosis

ISC Symposium (Abdomen)

SY09-2

Clinical Impact of DWI in Abdominal MRI

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DWI (diffusion-weighted imaging) has been currently in widespread use as a routine protocol even in the abdomen. DWI should be considered as an essential sequence rather than a supportive one although it is still challenging to remove various artifacts completely. For example, we are convinced of the power of DWI when we search for a lesion on non-contrast magnetic resonance imaging (MRI). Many reports about the utility of DWI have been worldwide published until now. According to them, DWI also plays a role for lesion characterization, determination of therapeutic effect and prediction of prognosis, etc. Furthermore, DWI has a potential of estimating the degree of fibrosis in each organ of the abdomen. Technically, several new scanning and analysis methods have been developed. They include the concept of intravoxel incoherent motion (IVIM) and computed DWI, etc. The diagnostic performance of DWI can improve as technology advances. I outline the clinical impact of DWI in abdominal MRI compactly in this lecture.

Keywords : Diffusion-weighted imaging, Abdomen

ISC Symposium (Abdomen)

SY09-3

Introduction of future technique

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Diffusion weighted imaging (DWI) was first implemented for clinical use for a neuro related study in 1986 (1). For the cancer imaging to detect the malignant cancer was reported since early 1980s (2). Nowadays, DWI is routinely used in clinical practice in many organs.

The scan technique now routinely used for DWI is the Stejskal-Tanner MPG implementation with a SE-EPI, or sometimes a turbo SE, as read out.

In this part of the session, I would like to talk about some of Work-In-Progress techniques for clinical MRI, namely multi-band SENSE, Motion Corrected MPG-DWI (MC-DWI), MultiVane DWI and SPLICE (split-echo acquisition of FSE signals).

Multi-band SENSE contributes to reducing the scan time, in particular for DWIBS (3) and breath hold scans. MC-DWI improves signal loss due to motion, such as signal loss in the left lobe of the liver due to cardiac motion. TSE based diffusion remediates geometric distortion in comparison with EPI based diffusion. Finally, SPLICE aims at improving the SNR for body diffusion.

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2) Le Bihan D. Intravoxel incoherent motion perfusion MR imaging: a wake-up call. Radiology 2008; 249: 748-752

3) Takahara T, Imai Y, Yamashita T, Yasuda S, Nasu S, Van Cauteren M. Diffusion weighted whole body imaging with background body signal suppression (DWIBS): technical improvement using free breathing, STIR and high resolution 3D display. Radiat Med. 2004 Jul-Aug;22(4):275-82.

Keywords : Diffusion, MC-DWI, Multi-band SENSE, SPLICE

ISC Symposium (Abdomen)

SY09-4

DWI for rectal MRI: pearls and pitfalls

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One of the most promising functional MR techniques for oncological imaging is diffusion-weighted MRI (DWI). Both the visual assessment of diffusion images, as well as the quantitative measurement of ADC, have shown great potential for rectal cancer imaging, for the evaluation of the therapeutic response of rectal tumors after chemoradiotherapy(CRT).

It has been shown by several authors that, compared with standard MRI, DWI offers significantly better diagnostic performance for the selection of patients with a good or complete response of their primary tumor after CRT. Although at present DWI is being investigated mainly in research settings and its true clinical potential has yet to be proven, DWI sequences are already frequently implemented into clinical protocols.

Usefulness of Diffusion studies in Rectal cancers.

Conventional T2-weighted images show very excellent performances on pretreatment MRI, however, the estimation of restaging on post CRT MRI has been regarded unsatisfactory for its low accuracy. The main difficulty in assessing the response to chemoradiation is the distinction between fibrosis with and without residual tumor. Although still controversial, many researchers have reported that MR DWI helps distinguish between residual tumors from fibrosis. DWI analysis is also known that it helps distinguish between good and poor responder of CRT. Because a nonoperative ‘‘wait-and-see’’ approach is increasingly recognized as a potentially good alternative to standard resection for patients with a clinical complete response after CRT, recent studies using DWI have focused on the prediction of complete response after CRT. For this purpose, various advanced techniques such as intravoxel incoherent motion analysis, histogram analysis and DWI volumetry have been studied in DWI analysis of rectal cancers.

Pitfalls of Diffusion studies in Rectal cancers.

Because of decreased resolution of the DWI, rectal cancers usually are assessed by adding DWI to the conventional high resolution T2-weighted images. DWI is also affected more severely by artifacts including motion and intraluminal air collections. Technical differences between DWI sequences used in each study (use of different b values and fitting models) may show different results. As for nodal staging, DWI has also been investigated, and although it increases nodal conspicuity, it lacks the ability to differentiate malignant from reactive lymph nodes.

Keywords : Diffusion imaging, Rectal cancer

ISC Symposium (Abdomen)

SY09-5

DWI for Small Bowel MRI: Pearls and Pitfalls

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Magnetic resonance (MR) enterography plays an important role in the diagnosis and follow-up of patients with Crohn disease (CD). As these patients with CD usually need repeated imaging examinations, the lack of radiation exposure is a major advantage of MR enterography over CT enterography. Diffusion-weighted imaging (DWI), which reflects diffusion of water molecules in biologic tissue, has been recognized as a new imaging biomarker for assessing bowel inflammation in CD. Active bowel inflammation in CD causes mural diffusion restriction with decrease in apparent diffusion coefficient (ADC) values. Although the mechanism of diffusion restriction in active bowel inflammation in CD is uncertain, it could be associated with mural inflammation and fibrosis. Up to now, there is no clear definition of diffusion restriction in patients with CD. Several studies use qualitative criteria with visual assessment, defined as hyperintensity on high b value DWI images and hypointensity on ADC maps compared with lymph nodes and the spleen.

DWI is a promising tool for evaluation of CD, as this sequence does not require intravenous contrast enhancement, and provides quantitative index. There are conflicting results about incremental role of DWI compared with conventional contrast-enhanced MR enterography. Because of high false positive rate and low image resolution of DWI, improved detection of bowel inflammation on DWI than contrast-enhanced MR enterography appears negligible. Nevertheless, DWI can be particularly useful in patients with contraindications to intravenous contrast agent administration. In addition, DWI has a potential role for quantitative assessment and monitoring of bowel inflammatory activity in CD. This lecture will discuss the use of DWI for the evaluation of patients with CD and unresolved issues regarding DWI.

Keywords : Diffusion, Small bowel, Crohn disease, MR enterography